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Plans for a 16-mile trunk sewer to drain the district between 75th and 87th Sts. in Chicago have been prepared by the sewer department of that city, with the intention of letting the contract for the work in the spring of 1896. Briefly described, the sewer will begin near the lake at 79th St., with a diameter of 3 ft., and, increasing 6 ins. in diameter every half-mile, will run west to St. Anthony Ave., where the diameter will be 5 ft. At this point a branch sewer 5 ft. in diameter will connect, and the sewage of both lines will discharge into a 7-ft. sewer running west to Morgan St., where the diameter will be 9 ft. At this point a pumping plant will raise the sewage to a 9-ft. sewer, increasing gradually to 12 ft. at its discharge into the stock yards slip at 40th St. The area drained will be 16½ square miles. The noteworthy feature of this plan is that it takes cognizance of the drainage canal by discharging into the Chicago River instead of into the lake, and is a change of the plan prepared in 1894. It is somewhat remarkable that of all the great trunk sewers which have been laid out in Chicago within the last three years, this is the first one to discharge at a point where the $30,000,000 drainage canal will take its outflow.

Typhoid fever is becoming epidemic in Chicago, according to the statement of the Health Department of that city. At present the disease is confined chiefly to the sections supplied by the one and two-mile Lake View and Hyde Park intakes, and has not reached the section supplied by the four-mile intake. The disease is thought to be due partly to recent dumpings of filth dredged from the Chicago River and partly to the regular sewage discharge into the lake. Action has been taken to stop further dumping of dredged matter and analyses are being made to determine the main sources of infection. Meanwhile the citizens are warned to boil all their drinking water and to take such other sanitary precautions as are necessary to stop the spread of the disease.

The Baldwin Locomotive Works, of Philadelphia, have closed a contract with the Russian government for 40 locomotives, 20 passenger and 20 freight engines. The Baldwin Works lately built several locomotives for the Trans-Caucasian railway. All the engines just contracted for will be Vauclain compounds of the heaviest type.

The Japanese government is about to build two new lines of railway, about 50½ miles long, between Hongo and Senjer, and Mita and Odawara, the latter an extension of the Tokaido railway. But, instead of asking for bids from abroad, in the old-time manner, the government only publishes its proposals and specifications in the Japanese language; states that it will publicly let this work to the lowest bidder, and compels all foreign bidders to come provided with interpreters and a Japanese technical and commercial agent. Times have changed in Japan.

The Uganda railway project, in Africa, has been advanced by the voting of $100,000 by the British Parliament for preliminary expenses. As projected, the line would commence at Mombasa, on the Indian Ocean, and extend to Victoria Nyanza, a distance of 650 miles. The estimated cost of putting it into operation is nearly $9,000,000. In the debate upon this subsidy it was stated that it lately cost about $100,000 to transport a steamboat to Lake Victoria Nyanza, and the English government is paying $185,000 per year to transport its stores to the lake. The enormous cost of freight stifles commerce, and the Parliamentary majority believed the railway would pay for this reason.

The Bechuanaland Railway, in South Africa, is in operation from Vryburg to Mafeking, about 75 miles, being operated by the Cape Government Railways under agreement with the government of Cape Colony. This part of the line cost $1,175,000, and has earned 4% on this outlay. It is now proposed to extend the road from Mafeking to Gaberones, 95 miles, and thence to Palapye, 175 miles further, and the cost is estimated at $12,500 per mile, including bridges. The company receives annual subsidies of $50,000 from the British government, and $25,000 from the British South Africa Co. for ten years, and these will be doubled when the road reaches Palapye.

A great Chinese trunk railway, from Peking to Chin Kiang, and possibly to Shanghai, has been authorized by the Emperor, says the "Peking and Tientsin Times." The "Times," however, is not enthusiastic about the appointment of the Viceroy of Nanking as general manager of the project, and says that in the past he has proved himself "a clever obstructionist of railways." Ten years ago he advised the construction of a railway to the South, but coupled his recommendation with the further advice that nothing be done until China could furnish the capital and all the materials of construction and operation. Times have changed, however, and the late war has awakened the Chinese government to the pressing need of internal communication; for with the navy destroyed the great tribute revenue from the South was at the mercy of the enemy holding the sea. The distance from Peking to Shanghai is 750 miles, and the crossing of the Yangtze is the chief engineering obstacle in the way.

The electric locomotive used in the Baltimore belt tunnel by the Baltimore & Ohio R. R. hauled a train of 27 loaded freight cars and two steam locomotives on a grade of 0.8% Sept. 22. The weight of the train is given as 1,200 tons.

Tests of curve resistance have recently been made by the Pennsylvania R. R. at New Castle, Del., with a view, it is said, to changing the alinement of the reverse curves at that place.

The most serious railway accident of the week was a side collision at Tunnelton, W. Va., on the Baltimore & Ohio R. R., Sept. 27. An eastbound train was pulling out from the station when it was struck on the side by a westbound train, which was coming from the side track onto the single main track. The engine struck the vestibule between the two rear cars, and several persons were seriously injured by steam from the boiler. The engineman of the westbound train claimed that he was given a clear signal.

A freight train on the Lehigh Valley R. R. struck a tree on the track near Hazleton, Pa., Sept. 27, and the engine and 15 cars went into the Lehigh River. Lumbermen were at work on the hillside, and one of the trees cut rolled down the mountain. A man sent after it found it on the track, but instead of starting to warn trains he began to chop the trunk. The train was running at good speed, but the crew saw the obstruction in time to jump, and nobody was hurt.

An explosion if 65 lbs. of giant powder occurred in the Belgian mine at Adelaide Park, near Leadville, Colo., Sept. 26, by which eight men were killed. It is supposed that a miner carrying the explosive to the drifts let it fall. The explosion caused a cave-in of part of the mine.

The Ireland building disaster having been referred to the Grand Jury, that body has found indictments for manslaughter in the second degree against the following men: Thomas Murray, mason foreman; Thomas Walker, superintendent; John H. Parker, contractor; Dennis E. Buckley, former Inspector of the New York Building Department; Charles E. Behrens, the architect, and Edward J. Yondale, the architect's assistant. The maximum penalty on conviction is 10 years' imprisonment.

The proposed grade crossing of the Harlem R. R. and the White Plains Electric Ry., at White Plains, N. Y., was the scene of a fight between the employees of the two companies on Sept. 27, when an attempt was made to string the trolley wire over the steam railway. The wire was stretched, but was then pulled down by a rope attached to a locomotive, and the crossing gates were also pulled down, injuring one man. Eventually the Harlem R. R. called off its men and the wire was again erected.

The decision to abolish grade crossings in East Boston and the apportionment of two-thirds of the cost of the work to the railway companies, will result, it is said, in the Boston & Maine R. R. and Boston & Albany R. R. abandoning their terminals at East Boston, removing their deep-water terminals to Charlestown and South Boston, respectively.

Reports of scarcity of public water supplies are becoming more frequent of late, especially in portions of Pennsylvania. At Hazleton, Pa., it was reported on Sept. 26 that the electric street railway had shut down for lack of water, and that a number of collieries and other industries were idle on the same account. At Shamokin a water famine was reported as imminent on the same date. The Schuylkill River has been running low at Philadelphia, threatening the water supply there, and at Wilkes Barre one of the water-works reservoirs is reported as about empty, and the limited supply very poor in quality. At Albany, N. Y., some of the reservoirs from which the gravity supply is drawn are stated to be empty. At Philadelphia and Albany there has been some strong talk regarding water waste, and the necessity of reducing it by more extensive metering, a remedy which experience elsewhere has proven a very effective one.

The Union Traction Company, of Philadelphia, was formally organized in that city on Sept. 17, with Mr. J. Lowber Welsh as President. This big corporation has absorbed the Philadelphia, People's and Electric Traction companies. The capital stock was increased to $30,000,000, with 600,000 shares of $50 each. Of the new stock the Philadelphia Traction Co. will get about 309,680 shares, the Electric 135,480 shares, and the People's Co. 154,840 shares. Messrs. P. A. B. Widener and Wm. L. Elkins, the controlling spirits in the Philadelphia Traction Co., also have control in the new corporation.

A water-power plant at Keewatin, Ont., on the Winnipeg River, with electrical transmission of 40,000 HP. to the city of Winnipeg, 129 miles distant, is proposed, the Assiniboine water-power scheme for the same city having come to nothing.

The people of Duluth, Minn., have voted to build water-works, 3,237 to 1,077, and against the purchase of the water plant of the Duluth Gas & Water Co., 2,667 to 1,656. In the summer of 1891 the city voted $800,000 towards the construction of works, and in the following November voted against buying the company's works for $1,950,000. The bonds named were never issued, owing to legal difficulties over the validity of the election. On Oct. 26, 1894, the people voted, 2,073 to 1,876, in favor of buying both the water and light plants of the company for $2,106,000, and of expending $600,000 for extensions. This election was afterwards declared illegal. Subsequently the company made an offer to sell its water plant alone for $1,800,000. The vote on this offer and on the construction of an independent plant resulted as already stated.

The new water intake tunnel at Milwaukee, described in our issue of Sept. 19, was put in use on Sept. 25. A banquet was held to celebrate the event, which was largely of the nature of an ovation to Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., City Engineer of Milwaukee, who has been engineer of the work from the start, and has overcome difficulties almost unparalleled in this line of work.

Carp in the reservoir of the water-works of Lambertville, N. J., are reported as having made the water so bad, probably from stirring up sediment, as to lead the company to resort to dynamite to kill them off. The carp developed in large numbers from a few put in some years ago.

The removal of culm and other impurities from the water supply of Harrisburg, Pa., is to be investigated by an engineer, to be appointed by city water and lighting commissioners and the city engineer. The sum of $1,000 has been appropriated for this purpose.

The railway traffic from Doncaster, England, after the Doncaster races in September, is one of the annual difficulties of the traffic managers. Between 3:30 and 11 p. m. 161 ordinary and special trains were despatched to all parts of the country, through trains being run by no less than eight railways. The 79 regular trains were sent from the station as usual, while the specials were despatched from platforms erected in the freight yards.

The New York Rapid Transit Commission, at the meeting of Oct. 1, discussed the maps presented by Chief Engineer W. B. Parsons, showing the size, location and use of all vaults under the sidewalks on Broadway below 59th St., and on Fourth Ave. below 33d St. Other maps submitted showed the location of all sewers and pipes affected by the proposed underground railways. With these maps was a report on the character and estimated value of this work. The commission made some changes in the location of stations, as proposed by the Chief Engineer. Mr. Parsons reported that plans for the railway structure itself would soon be ready.

## THE EFFECT OF THE CHICAGO DRAINAGE CANAL ON LAKE LEVELS.

Through the courtesy of the Chief of Engineers, U. S. A., we are enabled to present to our readers the report of the recent Board of Engineers appointed to consider "the probable effect of the operation of the Chicago Drainage Canal upon the lake and harbor levels and upon the navigation of the Great Lakes and their connecting waterways." The report is addressed to Brigadier-General Wm. P. Craighill, Chief of Engineers, U. S. A., and is as follows:

The Board met in Chicago Aug. 12, 1895, and on Aug. 13 and 14 accompanied the officers of the drainage canal over the line under construction. Every facility and courtesy possible has been extended by the trustees and engineers of the canal for a full investigation of the subject matter. A brief description of the canal is extracted from the printed report furnished the Board by these gentlemen:

The Main Drainage Channel of the Sanitary District of Chicago is now under contract from its confluence with the south branch of the Chicago River, at Robey St., in the city of Chicago, to its southern terminus, in Will county, Ill. At the southern end of the channel the controlling works will be located. Beyond these works, the construction contemplated by the District will be the work necessary for conducting the flow from the channel in conjunction with the waters of the Desplaines River, down the declivity to and through the city of Joliet, and making such changes in the Illinois & Michigan Canal as the new conditions developed will make necessary.

The first work put under contract extended southwesterly from the Willow Springs road, and these sections were numbered consecutively Nos. 1 to 14. Average length of sections, one mile. Easterly from Willow Springs road, the sections are lettered from A to O, omitting J. The lettered sections are, except for a short distance near Summit, entirely in glacial drift, defined in the specifications thus: "Glacial drift shall comprise the top soil, earth, muck, sand, gravel, clay, hardpan, boulders, fragmentary rock displaced from its original bed, and any other material that overlies the bedrock."

The sections from 1 to 14 were put under contract in July, 1892; from A to F were put under contract late in 1892 and early in 1893; and G to M, inclusive, were contracted for in December, 1893. Sections N and O were put under contract May 2, and Section 15 Aug. 27, 1894. Earth was first broken on "Shovel Day," Sept. 3, 1892, on the rock cut below Lemont.

The Desplaines Valley is traversed by the river from which it takes its name, a stream of wide fluctuations, with no constant and reliable fountain supply. During some seasons its whole discharge would pass through a 6-in. pipe, and at others its volume reaches 800,000 cu. ft. per minute. Then it rolls majestically along, flooding the whole valley. Such being the situation, control of this stream was a condition precedent to the successful prosecution of the work upon the main channel. This control has been secured by the outlay of nearly $1,000,000 in constructing what is known as the River Diversion Channel.

About 13 miles of new river channel had to be excavated with the location of the Main Drainage Channel, and about 19 miles of levee built to divorce the waters of the Desplaines watershed from the channel which is to receive the waters of Lake Michigan and pass them on to the Mississippi River via the lower Desplaines and the Illinois rivers. The width of the River Diversion Channel on the bottom is 200 ft., side slopes 1½ to 1, grade generally 0.12 ft. per 1,000 ft.

At the head of this river diversion it was necessary to provide a safety valve in the form of a spillway, to allow surplus water to flow toward Chicago, because arrangements have not as yet been perfected for carrying the entire flood waters of the Desplaines through Joliet.

This spillway is a concrete dam capped with cut stone, and its wings faced with stone masonry; it is 397 ft. long, and its crest is 16.25 ft. above Chicago datum (this datum is referred to the low water of Lake Michigan of 1847, and is 579.61 ft. above sea level at Sandy Hook). No water flows over this spillway until the volume passing the water-gage above it reaches 300,000 cu. ft. per minute.

The cross-section of the earth sections from A to E, inclusive, is 202 ft. on the bottom, with side slopes of 2 to 1. This section extends for about 500 ft. into the west end of F, and then reduces to 110 ft. on the bottom, preserving the same side slopes. The explanation for this change of cross-section is as follows: Throughout the rock sections, and those sections in which there is a preponderance of hard material, or where rock may appear, the section adopted is designed according to law for a flow of 600,000 cu. ft. of water per minute, which means provision for a population of 3,000,000 people. The narrow channel provides for a flow of 300,000 cu. ft. per minute, or for about the present population of Chicago. The enlargement of the narrow channel can be made by the easier methods of excavation, such as dredging, whenever the needs of the city require it. The grade throughout the lettered sections is 1 ft. in 40,000 (.025 ft. per 1,000 ft.), and the bottom of the channel at Robey St. is 24.448 ft. below datum. The numbered sections, from No. 1 to No. 6, inclusive, are underlaid with solid rock. The width of the bottom, in rock, is 160 ft., and walls of masonry laid in cement will be built upon the rock surface to a height of 5 ft. above datum. Sections 7 to 14, inclusive, are in solid rock; width at bottom, 160 ft.; sides vertical, prism taken out in three tsopes with offsets of 6 ins. on each side for each cut, making top width of 162 ft.; grade in rock, 1 ft. in 20,000 (.05 ft. per 1,000).

Section No. 15 is also in rock, and its cross-section is enlarged at its south end, so as to form a "windage basin," in which large vessels may be turned around. The controlling works are located on this section. These works will consist of gates or movable dams, by which the flow of water from the main channel into the tail race, which is to deliver the outflow into the Desplaines River, can be controlled.

This river below Lockport follows the trough of the valley down a steep declivity to the canal basin in Joliet. The fluctuations in Lake Michigan, by varying slope of water surface, will be felt at the controlling works, and provisions must be made to meet these fluctuations within a range of 5 ft. above datum and 8 ft. below, or an extreme oscillation of 13 ft. The fall from datum at the controlling works to the level of the upper basin will be about 42 ft. in a distance of about 4½ miles. As the plans for controlling works have not been finally adopted by the Board of Trustees, they cannot now be discussed.

The total amount of excavation involved in the construction of the main channel is 26,077,765 cu. yds. of glacial drift, and 12,071,668 cu. yds. of solid rock, or an aggregate of 38,149,433 cu. yds., to which must be added the material excavated from the river diversion: Glacial drift, 1,564,403 cu. yds.; solid rock, 258,926 cu. yds.; total river diversion, 1,823,329 cu. yds.; grand total, main channel and river diversion, 39,972,762 cu. yds. All of this work is now under contract, and in addition thereto 384,958 cu. yds. of retaining wall.

In response to the request of the senior member of the Board, the Board of Trustees of the Sanitary District of Chicago has furnished a report on lake level effects on account of the main channel of the Sanitary District of Chicago, containing briefs by Trustee L. E. Cooley, C. E., and by Thos. T. Johnston, Assistant Chief Engineer, accompanied by numerous blueprints. These papers present a full discussion of the subject as viewed by the canal officials.*

### What is the Outflow of the Lower Lakes?

In November, 1891, the Chief of Engineers, U. S. A., at the request of the Secretary of the American Society of Civil Engineers (who had been asked by the Chief Engineer of the Montreal Harbor Commission of Canada to suggest the subject), ordered a set of observations made to determine the amount of water flowing down the Niagara River. The time was especially propitious, as the water was then very low.

The results of these measurements were somewhat unexpected, and they were repeated in May, 1892. The second set corroborated the first, and the whole formed the subject of a report to the Chief of Engineers, which appeared in his annual report of 1893, pages 4, 364 and following. But, as the subject was important, the "Engineering News" anticipated the appearance of the official report by publishing in its issue of March 2, 1893, this report, with the permission of the Chief of Engineers. This publication was the first ever made in which, as a result of careful measurements, a relation between the level of the lakes and their outflow, or discharge, had been established and given to the public. Prior determination of this discharge had not attempted to detect this relation, and nothing more than a general determination of a season's work had been published. In all plans for the Chicago Drainage Canal, the early measurements had been taken, and those studying the subject chose such isolated figures as suited them best.

The report of 1892, being so late in appearance, long after the drainage canal was put under construction, escaped the notice of many who are interested in navigation for two reasons. Some were too busy to see anything, unless specially brought to their notice. Others thought the whole matter already fully canvassed, and settled. It is true there is nothing showing that the consent of Congress had been asked for this enterprise; certain that the subject had not been treated as an interstate affair, to say nothing of its being an international affair. The United States has always been slow to move; with its many sleeping rights, it has for many years been loth to exercise them. Not till 1888 did it begin to exercise positive legislation over its navigable waters in order to preserve them for all its citizens. Each river and harbor bill since then is found to have sections strengthening the hands of those who wish to keep the waterways open and in good order, for all classes of navigators. Not till 1890 had any prohibitive clauses been enacted into laws forbidding, for example, the destruction of channels by improper dumpings. Saw mills went their own unchecked way every year, clogging up the streams. Railways bridged all smaller streams, in the states, without interference from the United States. Many other features can be quoted. But it is sufficient to say that all that is now changed. The adopted policy is to defend, as well as improve, all water courses, now navigable, or probably navigable in the reasonably close future. Waterways are under the charge of the United States, and there is no likelihood of their being abandoned for some time to come.

With this an established fact it is impossible to think that United States supervision shall not be extended to the Chicago Drainage Canal in due time. Under whatever law built, and for whatever purpose constructed, just so soon as it is shown that that canal affects, or becomes a part of, the system of navigable waterways of the United States, some supervision or control of it must follow. When boats use it for harbor purposes; when its waters add to the Illinois River, or take from the lakes, they alter natural conditions, and the matter rises for consideration under national authority.

The water levels of the Great Lakes are very delicate. Storms, barometric changes, rainfall, even tidal changes, are felt. Records show at Buffalo no less than 13 ft. as a total possible change, between the lowest and the highest gage readings. Each lake is a basin. The water is constantly pouring in from not only one, but several inlets. The overflow, however, is now always out of the one outlet provided for that purpose; the second one, formerly at Chicago, has been plugged up.

As in our basins, when the water rises enough to take two, three or more of the small holes to carry it off, it is always to be noted that those holes are always carrying that surplus off; they do not wait until the water has time to pass from one end to the other. In the same channel the head alone governs the rate of outflow, and that head is measured by the gage-reading at the outlet. The supply of water in the lake, the net supply, allowing for evaporation, is the sole cause of the outflow. That supply depends solely upon rainfall, but the lake, when it receives more than it has been receiving, must discharge more; when it has less, there is less to run out. If the outlet be dug down, or new ones made, the water runs off faster than it ran off before.

The outflow is instantly affected by a changed inflow, provided there is enough such to increase or reduce the head. If we have a rainfall of 1 in. over the lake area (and such are not uncommon events), there is a head of 1 in. to run off. But if there are two outlets to run out of, instead of one, this inch must run off sooner than through the one. If the new outlet should reduce the levels of Lake Michigan and Huron about 6 ins., this effect will be produced in full in about two years; it is not then a question of many years, as some suppose.

We may feel very sure, therefore, that in this question two points are certain: 1. The drainage canal is not solely a state affair, but a national one. 2. The tapping the lakes must affect their levels. But it is said, first, that the changes in levels do not concern shippers, and then that, at most, the effects will be trifling.

If one watched carefully the course pursued by shippers one would see that, as a rule, each vessel carries all that it can take, and get out of its port, or into that it intends to reach. Vessel owners and managers are very shrewd, watchful men; they know what they can safely carry, allowing for storms and short detentions arising from passing causes; they average pretty well the practicable depths, and carry all the channels will stand. They are as conversant as are theorists about the effects of storms, but they keep good watch on ruling depths. Now, should it be certain that these average depths were reduced 3 ins., or 6 ins., they must load accordingly. And not only the large boats, but also the small ones using the small harbors that the large ones cannot go into. All must lose the 3 or 6 ins., as it may be; and not for one or more trips, but for all trips, and for all time; a diminution of capacity is not a single tax, but a continuous one. A vessel that when light draws 6 ft. and loaded 12 ft. must lose 3 ins. out of 72, say 4% in capacity, each loading; a vessel drawing 12 ft. light and 20 ft. loaded would lose somewhat over 3% in capacity at each and every loading.

Should the loss of levels be 6 ins. instead of 3 ins., then these figures become doubled. Will the loss be 6 ins. or will it be 3 ins.? This is an important question, and we have only the Niagara River discharge observations from which to answer it. These cover a range of about 1.8 ft. There were scattering observations outside these limits, but the mass of results was secured between gage readings, mean lake level, the highest, and 1.85 ft. The "smooth curve" as published enables us to note the fall of 0.53 ft. on the gage per 10,000 cu. ft. per second for the first foot of fall and 0.44 ft. for the whole.

These observations, especially at the lower readings, are erratic, and indicate a need for more measurements, especially at these levels. This lower portion of the gage should be studied and additional observations made, and the Board is a unit in suggesting the importance of a series of gagings of the St. Clair River at the present time for this purpose, and to furnish additional knowledge of the relation between gage readings and discharge. The subject is of such general bearing upon the navigation of the lakes that it demands careful treatment and full data. The Niagara data do not show how much Lakes Huron and Michigan would be lowered, even if 0.53 ft. were the net loss to Lake Erie. The opinion expressed by Mr. Johnston that the effect on the two upper lakes would be some 15% greater than upon Erie would seem to point to a probable loss of, say, 0.61 ft. This possible loss of 7 ins. certainly is important enough to justify careful measurements of the discharge through the St. Clair. It is true that the law as it stands, and the intention of the trustees, contemplate the abstraction of only 300,000 cu. ft. under present conditions; but after the canal is opened measurements would not be so instructive, and we must assume that ultimately the entire 600,000 cu. ft. per minute will be drawn from Lake Michigan, as required by the state law.

* The brief by Mr. Cooley is given on another page of this issue.

The abstraction of 10,000 cu. ft. of water per second from Lake Michigan will lower the levels of all the lakes of the system except Lake Superior, and reduce the navigable capacities of all harbors and shallows throughout the system to an extent that may be determined, if at all, by actual measurements only. Under the laws of the United States these changes in capacity cannot be made without Federal authority, and to enable the executive officers of the United States to act advisedly in the matter it is necessary, in the opinion of the Board, not only that these measurements be taken, but that the money cost of restoring the navigable depths in channels and harbors be carefully estimated.

In this connection the Board submits, without expression of opinion, an estimate prepared by Mr. Charles H. Keep, Secretary of the Lake Carriers' Association, of the commercial losses in carrying capacity of the lake fleet, should a reduction be made in lake levels of 1, 3 or 6 ins.

The Board notices that the same peculiarity exhibited by the Niagara discharge curve is pointed out by Mr. Johnston as existing in the Morris, Ill., and South Branch Chicago River curves.

The Board also notes Mr. Johnston's conclusions that,

"Applying the reasoning to the St. Clair and Detroit rivers, then the value of $Q' - Q$ may be taken from the diagrams illustrating the tables before described, the only uncertainty being as to the value of a. Suppose a to be unity, and the mean depth 20 ft. Then $Q' - Q$ will equal something greater than 20,000 cu. ft. per second.

This practically corresponds with the deductions made from the Niagara River observations.

So many uncertainties arise in the application of hydraulic formulas that the only way to ascertain the approximate discharge of these streams is to measure them for periods long enough to eliminate accidental fluctuations and to cover all stages.

While the navigable capacity of all harbors and channels on the Great Lakes below St. Mary's Falls will be injuriously affected by a diminution in depth, the navigability of the inner harbor of Chicago will be diminished also by the introduction of a current therein, which, in the present condition of the river, even with the minimum flow of 5,000 cu. ft. per second, or 300,000 cu. ft. per minute, is entirely inadmissible. The estimates of the effect of the drainage canal upon this harbor should also consider this element.

The Board of Trustees have not yet determined upon a plan of treatment of this navigable channel, and their plans may be such as may improve, impair or destroy its utility as a navigable river.

All of which is respectfully submitted.

O. M. Poe, Col. Corps of Engineers, Bvt. Brig.-Gen., U. S. A.; E. H. Ruffner, Major of Engineers, U. S. A.; W. L. Marshall, Major, Corps of Engineers.

## EFFECT OF THE CHICAGO DRAINAGE CANAL ON LAKE LEVELS.*

By L. E. Cooley, M. Am. Soc. C. E.

The Sanitary Canal of Chicago is now in process of construction under the authority of a law passed by the General Assembly of Illinois in 1889. This work is to be opened in 1896, or at the latest in 1897. The ultimate capacity of this channel is to be not less than 10,000 cu. ft. per second when the lake is at Chicago datum (the low water of 1847) which is 4.7 ft. below the high water of 1838 as established at Milwaukee. The law permits the channel to be developed through the earth sections on the basis of a capacity of 5,000 cu. ft. per second, provided that the same is enlarged with the growth of population to the ultimate capacity set forth, viz: 10,000 cu. ft. per second, said ultimate capacity being sufficient, in the view of the law, to so dilute the sewage of 3,000,000 people as to maintain a sanitary condition throughout the channel and in the streams into which the same is to discharge—the Desplaines and Illinois rivers.

Under the law a Sanitary District has been organized with original powers of taxation and indebtedness, governed by a Board of nine Trustees, elected by popular suffrage, and under the authority of this Board the work authorized is being prosecuted.

The work as now laid out provides for a Main Channel, which begins at a junction with the Chicago River, or rather the south branch thereof, in the southwest quarter of the city at a point 5.8 miles from Lake Michigan, by the course of the river, and extends to the vicinity of Lockport, a distance of 28.05 miles from the point of beginning, where the water is to be discharged into the Desplaines River, and such work done along the bed thereof, for a distance of 7.1 miles, as is necessary to conduct the overflow safely through the city of Joliet.

For 7.8 miles out from Chicago the channel is being constructed with a present capacity of 5,000 cu. ft. per second, the future enlargement being simply a matter of dredging through comparatively easy material. The 20.25 miles in the Desplaines Valley is through glacial drift of the most difficult character and through rock, and this part of the work is being carried out on the ultimate basis of capacity. The standard dimensions as adopted are, for 14.9 miles through the rock cut, 160 ft. wide at bottom and 162 ft. at the top, with a declivity of one foot in 20,000 ft.; and in the earth and drift for a distance of 13.15 miles, 202 ft. wide at bottom and 290 ft. at the water line when the channel is carrying 22 ft. of water, with a declivity of 1 ft. in 40,000 ft., excepting, however, the 7.8 miles at the Chicago end, previously mentioned, which are being constructed with a width 92 ft. narrower than the standard earth section.

The bottom of the channel, at its junction with the Chicago River, is actually 24.45 ft. below datum, and at the Lockport end 30.1 ft., the total theoretical declivity being 5.65 ft. The capacity is figured on a depth of 22 ft. on a conservative basis, so as to make sure of meeting any requirement of the inspectors, who are to be independent agents of the state. It will be noticed that an allowance of 2.45 ft. is made in the grade at the Chicago end in order surely to meet any solution that may be demanded through a connection with Lake Michigan, in order to feed this channel to its full capacity. These additional works have not been provided for, nor have plans for the same been matured. Should these works be carried out on a liberal basis, the depth in the Main Channel will be increased 2 ft. at low water.

It is proposed to open these works on the minimum capacity provided by law (assumed at not less than 5,000 cu. ft. per second, but actually 20,000 cu. ft. per minute for each 100,000 of population), and it is presumed that considerable work will be required in the Chicago River to pass the minimum volume without injury to navigation. Extensive works of a radical nature will be necessary to provide the ultimate volume, viz.: 10,000 cu. ft. per second, and several years will be required for their full developement.

The volume flowing in this channel will be regulated by controlling works at the lower end at Lockport, and by these means the discharge may be fixed and controlled at any amount, or entirely stopped at pleasure.

Aside from its sanitary utility, the Channel is to be regarded as the most costly part of a waterway from Lake Michigan to the Mississippi, and as a useful extension of the harbor of Chicago for vessels of deep draft, and these objects were contemplated as important incidents of the work, and were fully expressed as the policy of the state when the law was passed.

The question to be considered is the effect on lake levels of removing 5,000 cu. ft. per second in the immediate future, and ultimately of 10,000 cu. ft. per second.

### Technical Consideration.

All investigations have proceeded on the basis of 10,000 cu. ft. per second, and the ultimate effect on lake levels of diminishing the volumes passing through the several outlets and connecting channels of the lake system by this amount. The effect of any lesser volume will be in direct proportion to the effect produced by 10,000 cu. ft.; in other words, 5,000 cu. ft. will produce one-half the result.

In all these inquiries the lake system is to be regarded simply as a great river, subject to fluctuations the same as any stream, according to the supply of water draining thereto. It has annually its high water period and its corresponding low water period, and in some years this low water drops much lower than others, and again, in a series of years the high waters reach a limit much higher than others, all depending upon the annual precipitation and whether rain and snowfall are deficient or excessive, and also on successions of dry and wet seasons. The range of these fluctuations is much limited over the action of normal rivers on account of the reservoir action of the enormous lake expanses; and, also, on account of their great water surfaces, evaporation, wind and other effects, are important. It is assumed, however, that whatever in any degree affects one of the lakes in its water supply, will likewise in some degree affect all the others below it, depending on the area, local water supply, and the conditions of the outlet in each case. For instance, the St. Clair River runs at a higher elevation when carrying a volume of 230,000 cu. ft. per second than when carrying a volume of 10,000 ft. less., or 220,000 cu. ft. per second, the same as any other stream, and the level in Lakes Huron and Michigan is determined by the elevation of the water in the St. Clair River. In the same manner is the level of Lake Erie determined by the volume passing through the Niagara River and the local outlet conditions in the vicinity of Buffalo and Black Rock; and that of Ontario by the volume of the St. Lawrence and the conditions at the head of the Galop Rapids below Ogdensburg. Normally, the effect should be less down the stream on account of its increasing volume; in other words, the volume of the St. Clair River is diminished by a larger ratio than is that of the Niagara or St. Lawrence.

In the investigations heretofore made, the mean discharge of the St. Clair River has been taken at 225,000 cu. ft. per second, and of the Niagara River at 265,000 cu. ft. per second. (On the authority of L. Y. Schermerhorn, for many years assistant engineer under Colonel Roberts, and republished by Charles Crosman, of Milwaukee, in his chart of lake fluctuations.) These figures are based on the best available information collected by the lake survey. Assuming these figures to be correct, the abstraction of 10,000 cu. ft. per second will diminish the mean outflow in the St. Clair River by nearly 4½%, and in the Niagara River by about 3¾%. On lines of reasoning obvious to those unacquainted with hydraulic principles, it is apparent that the ruling depth in the rivers at mean lake level cannot be lessened by an amount greater than these percentages. Applying hydraulic principles, the effect will be only a fraction of that indicated by the reduction in volume.

The writer had the honor to lay the foundation of the present project in a report drafted for a committee of the Citizens' Association of Chicago in 1885, which was adopted by said association as the basis of promotion. His professional experience has lain along the lines of river hydraulics, and naturally the first matter to consider was the effect on lake levels of so bold a project, and this he satisfied himself of before the proposition was even suggested. In 1886-7 the matter was considered by the Drainage and Water Supply Commission, an engineering organization officially constituted to determine a plan for sewage disposal, and this commission also satisfied itself upon the subject before committing itself to the project. In January, 1888, the matter having been publicly raised, the writer discussed the question publicly for the first time in a brief, entitled "The Lakes and Gulf Waterway," now out of print. (Three editions were published, aggregating 15,000 copies.) Later in 1888-9 the matter was discussed at great length before the Western Society of Engineers by several well-known hydraulic engineers, and the discussions were published in the Journal of the Association of Engineering Societies in March, 1889. (Reprinted as a special edition of 5,000, and issued by the Citizens' Association of Chicago. In this discussion the matter included in the brief upon the "Lakes and Gulf Waterway" were republished.)

The discussion before the Western Society of Engineers may be considered as exhaustive, so far as the data existing at that time are concerned, and very little original information has been collected since. It was fully recognized that the data was inadequate for a positive determination, and the matter was approached by the several writers from various hydraulic standpoints, and the conclusions reached are to be regarded as settling limits rather than a specific amount. The concurrence of opinion was, however, most remarkable, and the actual results deduced varied between 0.2 ft. and 0.4 ft., as the probable effect of removing 10,000 cu. ft. per second through a new outlet. The effect at low water would be somewhat greater, and at high water somewhat less than at mean stage.

In 1891-2 some measurements were made of the discharge of the Niagara River opposite Black Rock. These observations indicate that the mean discharge of this river has been taken too high. They cover an inconsiderable range of lake fluctuations, there being but one low-water observation, and none much above the medium stage. These observations seem to indicate at and near low water an effect of about 0.3 ft. At medium and high stages the conclusion has been drawn that the effect would be greater. As such, deduction is at utter variance with all experience in hydraulics, any conclusions from these observations must await further measurements made at extreme low water, and also the necessary measurements at high lake, when, no doubt, the observations made will be found to indicate normal variations. These observations are printed in the report of the Chief of Engineers, U. S. A., 1893, p. 4,364. The official report ventures its inferences with proper caution, considering their singular character.

In a paper read before the Western Society of Engineers, in October last, Mr. T. T. Johnston, First Assistant Chief Engineer of the Sanitary District, concludes that no supposable condition could make the effect as great at 0.5 ft. Mr. Johnston approaches the matter largely on the basis of analogy with our large Western rivers, in the investigation of which he spent several years of professional life.

All dates and opinions up to this time seem to point to the conclusion that between low water and high water, and over a range of four feet, there is a variation in discharge of over 100,000 cu. ft. per second, and that to lower lake levels by 0.4 ft. would take over 10,000 cu. ft. per second. For the purposes of discussion the effect may be assumed at 0.3 ft. until determined by actual observations of the most painstaking character.

That there are many reasons for making these observations, in order to ascertain the effect of the deep-

*A report prepared for Harvey D. Goulder, Attorney, Lake Carriers' Association, and also submitted by the Trustees of the Sanitary District of Chicago to the recent Board of U. S. Engineers, appointed to report upon this question.

ened channels, of ship canal and water power schemes, and also for scientific purposes, is evident. When the facts are properly ascertained and valued, the effects of any given cause will reduce to a question of plain demonstration rather than of speculation.

Discussion.

The question at issue is a very sober one, the interests concerned are many and important, and conclusions are to be arrived at candidly and without distortion. If great public purposes may be attained without substantial injury to important interests, no objection should lie; and again, if injury is to occur, objection should content itself in providing the proper remedy.

It is assumed that any injury attaches to the effects produced at or near low water when the available depths for navigation are least.

It will be contended that the effects on the interests of navigation are immaterial; and further, if they be not so considered that the remedy may be easily applied. It is proposed to develop the several considerations which bear upon the question.

1. The Detroit River has been deepened at the Lime Kiln crossing from an original depth of 13 ft. to 21 ft.; the St. Clair Flats from 9½ ft. to 16 ft., with work now in progress for 20 ft.; work is in progress at the head of the St. Clair River, at the entrance of the Detroit River, and both above and below the Lime Kilns for 20 and 21 ft. The St. Mary's River had an original depth of 9½ ft., which was increased to 16 ft., and work is in progress both above and below the rapids for 20 and 21 ft. The Niagara River is having its barrier reef at the outlet of Lake Erie cut down to 21 ft. to extend deep water down to Tonawanda. The Canadians deepened the reef at the head of the Galop Rapids below Ogdensburg from 10 to 16 ft.

All these changes in outlet conditions necessarily have affected, and will affect lake levels, and some of them doubtless by sensible amounts that may be greater or less than that produced by the decrease in volume of water due to the new outlet at Chicago. This question has never been raised except in relation to the Canadian improvement at the Galop Rapids, and in that case was dismissed as immaterial after a learned technical discussion. (See report of Chief of Engineers, U. S. A., p. 2,470, et seq.)

It may be said with confidence that had the question not been raised in conjunction with the Chicago Sanitary Canal, all lake interests would have been equally oblivious to any injury that may follow: In other words, the effects are so obscure and ill-defined as to make their practical detection impossible by the ordinary commercial agencies.

2. If it were not known from technical considerations that lake levels were to be changed by 0.3 ft. (assuming that amount to be correct), it would be practically impossible to determine the fact by any measurements that can be made, or observations on lake levels continued for a century, and for the following reasons:

a. The mean annual fluctuations between the high water of late spring and early summer, and the low water of late autumn and winter is, for Lakes Michigan and Huron, 1.34 ft.; Lake Superior, 1.2 ft.; Lake Erie, 1.55 ft.; Lake Ontario, 2.07 ft. These fluctuations vary greatly in different years.

b. The fluctuation over long periods is from 4 to 5 ft., as from the high water of 1838 to the low water of 1847, a range of 4.7 ft. for Lakes Michigan and Huron, and still more to the low water of 1891-2. These fluctuations are irregular as to period, but usually pass over a range of 3 to 4 ft. every five to seven years.

c. Every change of the wind produces effects from a few tenths to extremes of several feet, depending on velocity and direction.

d. Rapid changes of barometric pressure produce sensible effects. A high barometer on Lake Michigan and a low barometer on Lake Huron can easily shift large volumes of water through the Straits of Mackinaw, and make a difference of level of one foot between the two lakes, and there are observations indicating such a result. A high barometer on Lake Huron and a low one on Lake Erie will increase the discharge through the St. Clair and Detroit Rivers, and possibly the discharge of the Niagara River may be varied from this cause.

e. There are periodic fluctuations occuring at short intervals of less than one hour, even in the calmest weather. Automatic tide gages show these fluctuations at all times, frequently of several tenths of a foot, and they are known on many occasions to have much exceeded one foot.

f. The difference in evaporation, one year with another, may easily exceed the volume to be abstracted; 10,000 cu. ft. per second would remove from the combined surfaces of Lakes Huron and Michigan in one year 2.97 ins. of water, and this is only one-half the difference in evaporation for the years 1867 and 1868, as reported by the Lake Survey.

g. The excess of water required to mature a corn crop over that required to mature a crop of small grain throughout the water-sheds of Lakes Huron and Michigan would supply the Sanitary Canal of Chicago several years.

Without raising additional points, supposing that observations for 20 years after the Sanitary Canal is opened, are compared with observations for 20 years previous, and it is found that the mean level during that period has stood 0.3 lower, would the evidence be conclusive? Might there not be changes in climatic conditions? May not the inhabitation of the watershed change conditions of drainage and absorption? May there not be carelessness in gage readers and changes in reference bench marks in 40 years? Are not the outlet sand shallows undergoing changes and improvements? Finally, take the records of fluctuations since 1838, nearly 60 years, and consider them carefully; are we not prepared to believe that the next 20 years will show a higher mean lake surface that the last 20, even after allowing 0.3 ft.?

If the normal changes in lake surfaces are so large and various as to obscure a specific change relatively small in amount, so that a vessel owner is obliged to employ experts and make critical scientific examinations through a series of years to ascertain if he be injured, we may relegate the matter, for practical purposes, to the purely scientific field. Under practical conditions, are vessel owners loading vessels to margins of 0.3 ft., or do they even work as close as that in ship canals where water level conditions are under control within close limits.

3. Any changes that have been made in lake levels heretofore have been the results of deeper channels, to which harbors and shipping had to conform, so it became a matter of no moment to any vested interest, and could at most have curtailed subsequent development by a very small amount. Any effect due to the Sanitary Canal, of Chicago, will occur on the eve of the opening of the new channels through the connecting shallows, and is not of importance to interests that are vested on present depths, and at most can effect prospective interests in this degree—that they will develop on a basis of 19.7 ft. and 20.7 ft., rather than 20 and 21 ft. If lake interests are to look forward to a progressive deepening of the connecting channels in may be dismissed, as the movement for still larger depths will take effect before vessel interests have generally exhausted the provisions that are now being made.

4. Assuming that the effect will be material, the remedy therefor is to be considered. In a discussion in the "Marine Review" of Sept. 7, 1893, Gen. O. M. Poe, in charge of the work through the connecting shallows of the lakes, in reply to an article by Mr. G. Y. Wisner, Civil Engineer, advocating the control of the level of Lake Erie by means of a dam at the head of the Niagara River, pointed out the cheap character of the work required to secure greater depths, should they be found expedient.

Aside from the works already provided for in connection with the new channel at Sault Ste. Marie, the cost of securing a navigable depth of 20 ft. is less than $4,000,000, or inside of $1,000,000 for each foot in excess of 16 ft., the ruling depth for many years past. Future increase in depth will doubtless be more expensive, as the quantities of material will probably increase faster than the cost will diminish on account of improved methods.

It is sufficient here to point out that the navigable depth may be readily increased, and at inconsiderable cost as measured by the benefits. Conceding the extreme effect of the Sanitary Canal, it will add to the cost of deeper channels in the future not over 1% of the ultimate investment in the Chicago enterprise. This will be offset many times when that enterprise is completed so as to be suitable for a harbor for lake shipping without cost to the general government, to say nothing of the advantage to all lake interests that will ultimately result through a navigable connection with the Mississippi Valley.

5. In the "Detroit Free Press" of Jan. 8 and 11, 1889, appeared two interesting communications upon the effect of the proposed water power canal at Sault Ste. Marie on the level of Lake Superior. This canal proposed to take out some 10% of the volume flowing over the rapids, and it was contended that the level of Lake Superior would be reduced thereby nearly 6 ins., diminishing by that much the depths of the U. S. canal and the approaches thereto.

Gen. O. M. Poe, in his reply, deprecates any alarm to the interests of navigation, and, admitting for the sake of argument the effect alleged, says:

> A simple, easy and inexpensive way of remedying the evils which the writer of the article seems to fear, would be to reduce the cross-section of the river by building a spur dam at the head of the rapids, thus intercepting an area equal to or even considerably less than the cross-section of the water-power canal; it surely would not require a construction of any great magnitude or cost, nor would it tax the ability and resources of the engineer to an overwhelming degree.

The same methods can be applied to the St. Clair, Detroit, and Niagara Rivers. It will be objected that local increase of velocity will thereby be occasioned, detrimental to the interest of navigation, but this will probably not be considered a serious matter by the official mind in view of the dyke built in connection with the deep channel through the Middle Neebish for the evident purpose of counteracting any effect which this new channel may have in lowering the water level in the St. Mary's River above, and at the Soo.

Without passing on the quality of this solution, it is sufficient to say that any ill effects can be met by narrowing the outlet channels, an adjustant that Nature itself might provide in the course of time, as it meets all abnormal disturbances of the balance of its forces.

6. A favorite project of the writer, which he has developed on former occasions, is to fully control the outflow of Lake Superior by work on the Sault Ste. Marie Rapids for the purpose of permitting a much larger supply of water to be taken from the lakes at Chicago for the purpose of improving the low-water navigation of the Mississippi River.

The high water period in Lake Superior is later than in the lakes below, and the water therefrom comes in on top, and behind to swell and prolong the high water stage. Suppose that the flow from Lake Superior were restrained during the spring and early summer, and were allowed to come out later in the season and during the winter. It is apparent that high water on the lower lakes would be restricted and the lower stages better maintained. It is estimated that by thus controlling the outflow of Lake Superior it would be feasible to remove three or four times the volume provided for in the Sanitary Canal, or 30,000 to 40,000 cu. ft. per second, without impairing low water stages or the minimum depths available for navigation.

If this proposition is feasible from a technical standpoint, then sufficient control of Lake Superior to correct any effect that may be occasioned by the abstraction of 10,000 cu. ft. per second, presents no engineering difficulties of a serious character.

7. It has been proposed to control the level of Lake Erie by a dam across the Niagara River. Such a project has been seriously advocated for some time by G. Y. Wisner, Civil Engineer, of Detroit, and the proposition was presented to the Toronto Deep Waterway Convention in September last by the Cleveland delegation and heartily endorsed by the assembly. The arguments advanced are to improve the depths at the Lime Kilns and vicinity and in the lake near the mouth of the Detroit River, and in all the harbors of Lake Erie and the approaches thereto. This project has been advocated entirely independent and apart from any considerations based on the effect of the Sanitary Canal of Chicago.

The project has great merit, and hardly needs more than a clear statement of what it is proposed to do to commend itself. If any such project is to be carried out, it effectually disposes of the Chicago question; for it will be feasible to control an additional depth on Lake Erie several times any effect that can be assigned to the Chicago enterprise.

8. The movement for ocean navigation into the lakes that is now beginning to crystallize, and the sentiment for which was voiced by the international convention at Toronto in September last, is one which will excite a deep and growing interest throughout all the region tributary to our lakeboard, and is likely to grow in force more rapidly than any one realizes who has not made a deep study of economic factors and the engineering possibilities. When such a movement materializes into engineering forms, our lake problems will be looked at from a very different standpoint and the matter of controlling lake levels and meeting such problems as that at Chicago will take on a more purely incidental character.

9. The introduction of high powered vessels of deep draft to carry large cargo with speed will bring to the mind of practical navigators a question which has not heretofore appealed to them on drafts of 16 ft., and that is the necessity of wider channels and ample clearance beneath the keel. It will be found difficult to handle vessels in a crowded stream with only 1 or 2 ft. beneath the keel and under the influence of varying currents and winds, and that no considerable speed can be made under such conditions. It has been stated that the great Atlantic liners are unable to make their best time in less that 1,000 ft. of water, and every one acquainted with Western river navigation is familiar with the effect of an attempt at speed when the depth is small in proportion to the draft of boats. The interests of lake navigation to-day are certainly sufficient to justify channels of 24 to 26 ft., even though the harbors should be limited to 20 ft., and should an ultimate depth of 26 ft. be the future policy, the connecting channels should be deepened to 30 ft. and upwards. If any such development is to be the logical outcome of growing lake interests, the effect of the Chicago Sanitary Canal sinks into insignificance.

Conclusion.

We may conclude as follows:

1. That the data is insufficient to reach a conclusion as to the specific effect, and that the information available indicates limits not less than 0.2 ft., and not exceeding 0.4 ft., between which the final determination will lie.

2. That the magnitude and character of lake fluctuations are such that if the effects were unknown from purely scientific observations and measurements and technical analysis they would never be discerned or appreciated: in other words, lake phenomena are so active and of such amplitude that results relatively small are entirely masked.

3. That conceding any effect that may be claimed, several remedies are feasible therefore, any one of which can be applied at a cost relatively small as compared to the cost of the Sanitary Canal of Chicago, and that the expense of such application will be a small part of the benefits which lake interests will ultimately derive through that work.

4. That the future of lake interests and their seaboard connections will demand a radical deepening of the shallows of connecting channels, and a control of lake levels so that the interest in the question raised will reduce to a technical discussion in hydraulics.

5. That a careful remeasurement of the outflow of the several lakes under all conditions is desirable as the only final arbiter of any lingering doubts, and also for the more important purpose of projecting future works of a radical character and valuing the effects thereof.

The discussion has proceeded on the basis of the effect of 10,000 cu. ft. per second. It is proper to call attention to the fact that it is proposed to open the channel in 1896 or 1897 on the basis of 5,000 cu. ft. per second, and that extensive improvements of a radical character must be made before the channel can be utilized to the full capacity ultimately contemplated, and that several years will elapse before these are fully consummated. The time will, therefore, be ample to make exact determinations and without prejudice to any material interest.

This discussion is not to be regarded as the official expression of the Board of Trustees, but rather as the individual view of one of the trustees, who was the first Chief Engineer of the District, and a promoter of the enterprise from its inception.

Addenda.

The above brief should be emphasized along the line of the amount of clearance beneath the keel, as particular stress has recently been laid on the value of small changes in depth.

The recent fleet that is built to utilize the new channels of 20 and 21 ft. is actually molded for a draft of 18 ft., and this will be substantially the maximum loaded draft. The reason is obvious: Large vessels must have some clearance in order to navigate with any freedom and safety, and 2 or 3 ft. is a small enough margin for safety, considering the obstructions that may lie along the bottom, as sunken logs, and boulders carried in by the ice; and, also, for the reason that lake fluctuations are too erratic to make a closer margin safe. Under these considerations the value of a minor change of level, such as may be produced by the Sanitary and Ship Canal of Chicago, becomes a matter of relatively small consequence through the deepened connecting channels of the several lakes.

The same conclusions apply to the harbors, only in less degree. The larger harbors will surely be deepened to meet the requirements of the new fleet. Considering dredging methods on the practical side, a small fraction of a foot partakes of a paper discrimination of little moment outside the office. The smaller harbors, frequented by boats of light draft, engaged in the lumber and coasting trade, are so much under the influence of beach movement and other deposits that it is a wise navigator indeed who can tell within a few inches how much cargo he can carry on successive trips.

The only practical rule followed is to go safe, and the margin of safety is not measurable by the limits assigned to the effect of the Chicago Canal. If it be admitted that the working draft of vessels will be affected at all, the matter is surely one incapable of practical valuation on the financial side. It belongs to the indefinite realm, like rain, dew, fog, sunshine, temperature, evaporation, etc., small margins in which are incapable of valuation in relation to material affairs, and the most that can be said is that certain tendencies make for good, while others make for bad, and that all effects are relative. In summing up the questions, positive and negative results must be considered, and a balance struck with reference to the common welfare.

Unquestionably the entire Chicago enterprise is prejudiced by the pessimistic talk against the ship canal and navigation idea. As long as the idea of a scheme of national benefit, through the connection of the lake region with the Mississippi Valley, was held out as a realizable project of the early future, the people bordering the lakes were willing to resolve their doubts in regard to lake levels in Chicago's favor, as were also the people along the Illinois and Mississippi rivers willing to waive their doubts on the sanitary side.

The reaction against this idea is of the most ephemeral character, and such as occurs periodically in the history of all great enterprises. The people of the state at large are almost unanimously in favor of the carrying out of the waterway idea on the broadest possible lines, and have fully expressed their policy in this regard through the general assembly in the "Act to promote the construction of waterways," passed June 14, 1895, in the following language:*

It is hereby declared to be the policy of the state of Illinois to procure, as soon as practicable, the construction of a trunk waterway through the state from Lake Michigan via the Desplaines and Illinois rivers to the Mississippi River of such dimensions and capacity as to form a homogeneous part of a through route from the Atlantic seaboard to the Gulf of Mexico.

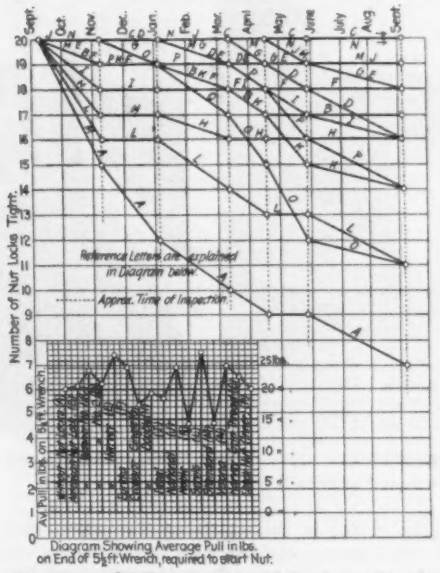
This policy represents also the views of a large majority of the people of Chicago, and there is little question but what matters in connection with the Chicago enterprise will shape themselves along these lines in the near future, and further, that the state will enforce the broad view in due season.

I assume that Chicago must sooner or later meet the issue, not only on the side of the lakes, but also on the side of the Mississippi Valley, both on lake level and sanitary effects. She will have but one valid defense, and that is along the lines which sees Chicago's greatest good in the good of the state and nation.

* This bill was vetoed by the governor on June 26, after the adjournment of the general Assembly.

## THE COMPARATIVE EFFICIENCY OF TRACK-BOLT NUT LOCKS.

In our thesis competition of 1893, one of the theses which received an Honorable Mention was entitled "An Experimental Study of Railway Track Joints." The author, Mr. G. E. Hayward, a graduate of Ohio State University, and now located at New Philadelphia, O., carried out an interesting series of tests with an automatic machine of his own invention which determined graphically the actual deflection of various joints




Diagrams of Efficiency of Nut Locks on Track Bolts.

(20 locks of each kind put in service Sept. 8, 1892, and test continued for one year. Vertical dotted lines show dates of inspection.)

under a train. At the same time he made a test of 14 kinds of nut-locks for track bolts, to determine their relative efficiency.

The following is his description of this test:

The diagram represents the result of test beginning Sept. 8, 1892. There were 20 samples of each of 14 kinds of nut locks placed in the track, and against these 20 bolts without nut locks and 20 with check nuts were tested. They were placed in the main track (Zanesville & Ohio Ry.), on tangent, 1% grade, the track having 56-lb. rails, 4-bolt angle bars and ¾-in. bolts with hexagonal nut ¾ in. thick. The traffic was light, and the maximum engine weight without tank was 94,000 lbs. No switching was done over this track, which insured the same traffic over all the samples tested.

The locks were placed and nuts set up until they were pronounced tight. Then they were gone over again, and care taken to have each screwed up flush, except in the case of the Standard, where 20% "set" was left, according to instructions from the manufacturer. After the test in the track was completed, the pull necessary to start the nut forward was measured, the pull being exerted on the end of a 5½-ft. wrench. The diagram shows the average for each kind. The results are simply for comparison. Effort was made to secure uniform conditions in all ways possible, in order to offset the fact that the number placed was limited.

Special orders forbidding the trackmen to tamper with the bolts were given and observed. The track went through the ordinary surfacing, alinement and repairs. Each nut was subjected to regular inspection by smart tapping with an iron bar, practice enabling the inspector to readily detect any looseness. When any nut was found loose, it was promptly tightened up to protect the others, but was marked with durable paint and counted out of the race in later inspections.

As is shown, the Verona and American Lock Washer No. 1 held all the bolts to which they were applied, with several other nut locks as close competitors. It is not claimed that it is a conclusive test. There are some conditions which cannot be made equal, such as differences in bolts and ties, though ties were of very fair quality, and bolts alike; yet it gives a general idea. Another series of four kinds of nut locks was placed in February; namely, the Dill (positive), Young (reversible), Positive (spring), and the Champion (bolt). Two of the Champion bolts worked loose. The others kept tight.

## RAILWAY TRACK AND MAINTENANCE.*

1. How Many Frogs and Switches Shall Call for an Extra Man in the Section Force?—The amount of traffic over the frogs and switches should determine to a very great extent the number of frogs and switches to each man in the force. We consider that 15 frogs and switches would necessitate the employing of an extra man in the section force, as an average on the line of a railway. C. C. Elwell, J. W. Shanks, J. R. Patch.

2. Rail Joints; Experience with New Devices.—Your committee has been confined to such joints as have been offered for trial, and has only to report on two, the Weber and the Continuous. We consider, after careful investigation, that either is an improvement over ordinary joints heretofore in use, but that for all purposes of strength, simplicity and wearing quality and economy of maintenance in track the Continuous joint is to be preferred. As an advance towards better joints, we would suggest the advisability of having the rail ends miter cut, instead of square, greatly diminishing the shock to wheels, and consequent wear both to rails and rolling stock. A. C. Stickney, J. W. Shanks, C. B. Lentell, G. A. Demore.

3. Track Tools, Nutlocks, Spikes, Bolts, Rail Braces and Tie-Plates.—This committee was continued from 1894, and makes the following report:

(a) Track Tools.—To avoid loss of time and money, and to secure the best results, each section should be supplied with track tools in abundance and of the best quality and design. This admitted, the adoption of standard track tools should be carefully made. The use of steel, instead of iron, as formerly, should be carefully considered in order to effect as great a reduction in the weight of tools as possible without loss of strength. Tools thus reduced to their minimum in weight would not only cost less, but would be much more easily and quickly handled by trackmen. The fact being that the design and weight of track tools are of fundamental importance, and that different roads and roadmasters entertain views so widely divergent, your committee, instead of specifying any particular weight or design at this time, would recommend that a committee be appointed to secure samples of the different track tools, with plan or print of the same, giving size and weights, to be presented at our next meeting for discussion and adoption, after possible modification. This method appears to your committee to be the only feasible way to secure unity of action among the different members.

(b) Nutlocks.—We would recommend that nutlock which, by its form or shape, will not catch in the hole of the joint fastening when being used; will not rotate with the nut; will not injure the threads of the bolt or nut, and will retain its spring after nut is loosened, all being dependent upon the proper quality, hardening and tempering of the steel; or, in other words, a double-spring nutlock.

(c) Spikes.—We would recommend a spike made of mild steel, size 9-16 × 5¼ ins., with reinforced throat, to insure longer life, and having a point with sharp cutting edges, so as not to mutilate the fibers of the tie.

(d) Bolts.—We would recommend a bolt of good quality mild steel, with threads so made on both bolt and nut that the nut can be screwed on by the fingers for the first three threads only; remaining threads to be turned by wrench, but loose enough to prevent bursting the nut; with cup head having oval neck that fits tightly the entire width of the hole of joint fastening; bolt ¾ in. diameter, nut 1⅝ ins. square; with ideal nut for rails less than 4½ ins. high, U. S. standard rolled thread.

(e) Braces.—Where tie-plates are not used, we would recommend a brace made of malleable iron or soft steel, about 8 ins. long, so made as to allow for reasonable shimming without pulling the spikes from the brace, and to fit perfectly against the under part of ball and neck of rail.

(f) Tie-Plates.—Your committee gave its recommendations at last year's meeting, advocating the use of

* Abstracts of committee reports presented at the annual meeting of the New England Roadmasters' Association, held at Boston, Mass., Sept. 18 and 19.

such plates, and makes no change in the recommendations then presented. C. H. Bryant, J. W. Drew, W. E. Tuttle.

4. Tie-Plates: Under What Conditions are the Best Results Obtained from Their Use? Their Value in Keeping the Track to Gage and in Preserving the Tie.—In the report of the Committee on Tie-Plates accepted last year by this Association, their use was advocated under certain conditions, to which report the members are now referred. In that discussion it was shown that the use of tie-plates not only adds life to the tie, but is a saving of labor to the trackman. The best results obtained from their use should be ranked in the following order:

At terminal yards, where, on account of frequent switching and the use of sand, the rail base cuts into the ties quickest and their renewal interferes most with the traffic, and where the least labor can be performed by trackmen.

At bridges, where the first cost of the ties and the expense of fitting them warrant the use of tie-plates.

On sharp curves, to save the uneven wear of the rail heads; to save the frequent adzing of ties, with loss of their thickness; to save the frequent respiking; to give correct gage and to keep the alinement of the curve, so as to prevent the oscillation that wears the rolling stock.

At switch runs on main line, under those rails that cut into the long ties, requiring expensive renewal, while the tie is good under the other rails.

At joints, on tangents, to save the rail ends from crippling, especially in double track, where the blow of the wheel is in one direction.

On tangents, where the ties are cut out before they decay.

As regards the second clause of the question, refer to the five benefits derived from the use of tie-plates as reported in last year's report—namely:

The decreased annual outlay for ties through their greater longevity, and the correspondingly lessened cost of labor in replacements.

The lessened amount of labor necessary in maintenance, such as tamping, shimming, gaging and lining.

The preservation of angle bars and bolts, and the true surface of the rail.

The double resistance of lateral pressure.

The saving in power and wear to rolling stock through the above results. E. H. Bryant.

5. Experience in Regard to the Beveling of Iron and Steel Rails. Is One Side of the Rail Higher than the Other, Requiring that the Lower Side be Turned in, in Order to Better Fit the Tread of the Wheel.—In a rail properly made there is no need of turning rails to have the brand either outside or inside when laid. Lay them as they come from the mill, having ties level, to give an even bearing for wheel tread on top of the rail. We do not know of any rails rolled today but those designed to be alike on both sides of the head and base. Wm. E. Clark, M. E. Drew.

6. How Can We Reduce the Number of Frogs Carried in Stock?—As each particular section of rail calls for frogs to match, it is advisable to have as few patterns of rail as possible on any one division.

Do away with half sizes and fractional numbers of frogs; for example, instead of having No. 8, 8½, 9, 9½, etc., have only No. 8, No. 9, etc.

Adopt a standard main line frog, and in all new construction and renewals use this standard, and thereby in time get rid of all odd sizes of main line frogs. Your committee recommends a No. 10 for main line standard.

Also adopt a standard yard frog, and in all new work and renewals use this standard. Your committee recommends a No. 8 for yard standard.

Special frogs should be used only where standard frogs cannot be used, and your committee fully recognizes the fact that many times only special frogs can be used. G. L. R. French, P. A. Eaton, J. W. McManama.

## A MELAN CONCRETE ARCH IN EDEN PARK, CINCINNATI, O.

By Fr. Von Emperger, C. E.

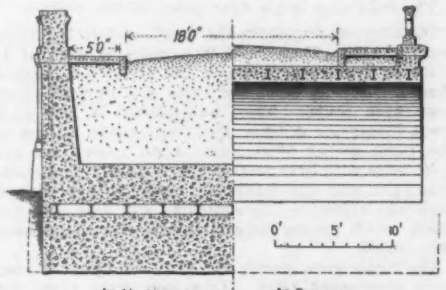
The concrete arch illustrated in the accompanying engravings is located in picturesque Eden Park, and pride of Cincinnati, and crosses Park Ave., the main thoroughfare of the Park. It connects two hills, on one of which the city water tower is situated, while the other promontory skirts the Ohio valley and commands a splendid view of the suburbs of Cincinnati and the Kentucky border up to Fort Thomas. The beauty of this landscape was lost on me when I commenced concrete work on this bridge in the middle of November, 1894, with the intention of finishing it before the ensuing winter. It is not only far colder on these hilltops than in the city below, but there is always at this season of the year a fierce wind blowing through Park Ave., and the idea of working concrete at temperatures below 26° F. (up to which limit it can be done with no great precautions) had better be abandoned.

The arch has a span of 70 ft., a rise of 10 ft. and carries an 18-ft. roadway and two concrete sidewalks of 5 ft. each, the whole width of the bridge, including railing, being 32½ ft. The concrete is 15 ins. thick at the crown and 48 ins. at the haunches. It is built according to the Melan system, being reinforced with 9-in. I-beams weighing 21 lbs. per ft., spaced 36 ins. apart, and supported by a cross channel at each end. The foundations are bedrock limestone, with a few layers of decayed, clay-like material, but altogether solid enough to justify very small abutments.

MELAN CONCRETE ARCH IN EDEN PARK, CINCINNATI, O.

IRON RIBS OF EDEN PARK CONCRETE ARCH.

Designed and Built by F. von Emperger, C. E.




Cross Section of Eden Park Arch.

The spandrel walls on top of the arch were continued as wing walls, according to the profile of each hill, and were reinforced by pilasters, as shown. This, as well as all the other detail upon the facade, was attained by constructing a corresponding wooden molding, behind which concrete of 1 cement, 3 sand and 6 stone was rammed in 6-in. layers, with colored face mortar at least 2 ins. thick on the outside. When these moldings are removed early, it is comparatively easy to make a smooth finish; but in some instances, as, for example, in the sudden snowstorm of Dec. 4, 1894, we were compelled to leave part of the molding on the work to protect the newly-set concrete. As some parts could not be finished for some five months afterwards, it then required considerable work to do the finishing on account of all the hardened irregularities which must always be expected from board lines and the like; but the snow and frost themselves did no damage, except to the ornamental key piece, a few of the projecting leaves of which required some repair. For forming this piece a casting of plaster of paris was used, made from a wooden model, and this, on account of its hygroscopic qualities, required to be removed as soon as the concrete had set. The concrete casting should have had very careful and continuous wetting for a couple of days afterwards, but this naturally had to be neglected on account of the frost and storm.

To avoid a misconstruction of this statement, I want to say that in my opinion, under the average circumstances, concrete work is more easily performed during the cold than in the hot months, but the site of this bridge is such that even the workmen refused to work if the weather grew colder. I succeeding in completing the main part of the work before the winter (only one face wall had to be built during some warm days in January under the supervision of Mr. Ludwig Eid, of Cincinnati, who also had charge of the rest of the work).

There are many engineers who do not admit that well-made concrete work is weather-proof,* notwithstanding the fact that most American cities have plenty of concrete sidewalks to prove it.

For this reason the position taken by Mr.

* The following is a testimonial bearing on the weatherproofness of the first Melan bridge built in this country in the summer of 1894:

Office of the City Recorder,
Rock Rapids, Ia., July 5, 1895.

Mr. I. F. Ackermann,
City Clerk, Plymouth, Wis.

Dear Sir: The Melan cement bridge, of which you desire information, is five miles from here, and was built by the county, and not by the city.

I visited the bridge recently, and find that the cold weather had no more effect on the work than on so much solid stone. In fact, the bridge is solid stone now, being made of crushed Jasper stone and imported Portland cement. The bridge is all O. K., and will last forever.

Yours truly, (Signed) J. K. Medberry,
Recorder.

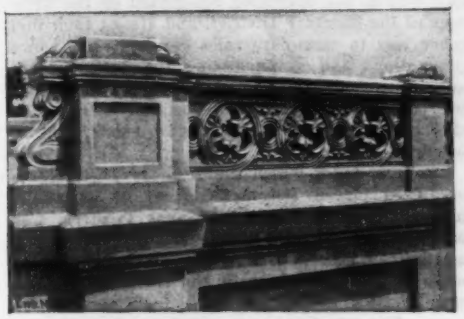
This bridge is a span of 36 ft., and was built by Messrs. S. M. Hewett & Co., of Minneapolis, Minn.

Warder, the Superintendent of Parks, who supported and favored this style of bridge, deserves full credit, especially as he is not an engineer by profession.

Plans for both stone and concrete arches were admitted to competition in the letting, and it was required of the latter that everything should be of concrete. It was not even permitted to make the arch imitate stone by making fancy joints, such a design being branded as an architectural lie. This explanation is made to show how the present design originated. The bids for a stone arch ranged in the neighborhood of $12,000, while the bridge as it now stands was contracted for by the writer at $7,130.

To remove the grayish and lusterless cement color, the specifications prescribed that colored mortar should be used in making the face. The colors at our disposal were yellow, black and red. The latter and dark green are advantageously used where the concrete has to imitate stone. In the concrete arch at Munderkingen (Germany), for instance, the arch stones were colored red, while the spandrels were colored dark green. For this reason the black and the red were declared out of the question, and there remained only yellow, which was added at the rate of 10%, the limit to which color should be used. The coping, railing and the arch proper are not colored.

After the excavation was done and the falsework erected, the bent ribs were laid, splices and cross angles fastened and the concrete in the abutments started, so as to enclose the ends of the iron ribs. Then some of the wingwalls and pillars



Concrete Railing, Eden Park Arch

were built, just to train the workmen, which were common laborers paid at the rate of 13½ cts. an hour. The arch was built in two longitudinal halves, each of them started on both sides, and closed up to the center in one day of 12 working hours with a force of 40 men mixing, wheeling and ramming 80 cu. yds. of concrete. The concrete in the arch was in the proportion of 1 : 2 : 4 (which had to be increased to 1 : 4, as the broken stone furnished was too small, and there was no time to substitute larger).

After this the above-mentioned molding of the center ornament was set in place and the facewalls completed, as already described. Immediately after the removal of the boards placed on the inside of the facewalls, the filling of the bridge was put in and completed to the level of the copingstone, where the work was stopped during the winter. The artificial stone for the railing and coping were cast during that time and were stored near the bridge. In the spring the falsework was struck and the work completed.

After the removal of the falsework the filling was compressed with a 15-ton steam roller, which was a very trying test, as the filling at the crown is not more than 6 ins. thick over the concrete, and the specifications only require the finished bridge to carry this load. There is no necessity to explain what the difference is in the distribution of the load if such a steam roller is used on an asphalt pavement with a solid foundation or on the bare concrete arch. Although they were not entitled to such a test, I was glad to comply with the desire of the city authorities, feeling confident that such a load could do no harm to the bridge.

Very careful measurements were taken after the removal of the falsework and on other occasions, and did not show any measurable settlement or deflection, which was partly due to the heavy dimensions, but also to the very long settling time given to the bridge before striking centers.

The cement used was "Porta" cement, from Bremen, Germany, and tests of same made by the writer and the city gave satisfactory results. The stone used was crushed limestone, as hard as it was possible to get in the neighborhood. For the exterior of the bridge and the artificial stonework mortar made a fine, sharp sand, carefully sifted, was used in the proportion of 2 cement to 3 sand.

## CAR HEATING BY ELECTRICITY.*

By J. F. M'Elroy.

The general principle employed in the construction of electric heaters is that of placing in these heaters suitable resistances, which become heated by the passage of the electric current. In the Burton heater, one of the earliest electric heaters tested on the electric railways in this country, a resistance wire made of German silver was bent in a zigzag form and placed within the hollow space between two iron castings. The wire was embedded in powdered fireclay and the castings bolted together. These two castings, which together formed the casing or outside of the heater, had a roughened surface for the purpose of enlarging the radiating surface. It was claimed that the embedding of the resisting conductor within a powdered mass of fireclay prevented the air from reaching the conductor, and hence prevented its destruction by oxidation when exposed at high temperatures of air.

Oxidation in a resisting conductor may be retarded if it is possible to keep the oxygen of the air from reaching the surface of the conductor, but by such a construction results may be reached which are just as objectionable as the oxidizing of a conductor by contact with air. The embedding of a resisting conductor in powdered fireclay, or other material which, from its very nature, would be classed as a non-conductor, would retard the escape of heat. The objectionable result is then reached that the temperature of a conductor rises to such a degree that the life of the conducting material is soon destroyed. Other electric heaters were put upon the market, but much difficulty was experienced, either from the oxidation of the resisting conductor, or from its destruction by fusion when enclosed in a mass of material, such as is shown in the Burton heaters.

High temperature is one of the conditions leading to the destruction of the resisting conductors, and while this difficulty is not experienced at 300 or 400°, it is always experienced when the metals are heated to a temperature of 900 to 1,200° F. Another condition is the crystallization of the conductors at high temperatures, and this is specially the case with German silver or any alloy. It is not necessary to run near to either of these danger points. The temperature of the resisting conductor depends upon the amount of heat which that conductor gives out per square foot of its surface, and the total amount of heat would, therefore, depend upon the number of such units of surface which there may be in the conductor. The reduction of temperature in the resisting conductor may be carried to any extent desired by simply increasing the amount of actual surface in the resisting conductor, its temperature thus being reduced to a point where the conductor is absolutely safe and its life is permanent.

In the construction of the heaters made by the Consolidated Car Heating Co., of Albany, cylindrical porcelain tubes are threaded upon a ⅝-in. square iron rod, the tubes having on the surface a spiral groove which runs from end to end. A porcelain disk is placed at each end of the heater, and when desired one is placed at the center to furnish a support for the binding screws, to which the ends of the resisting conductors are attached. No. 20 B. & S. galvanized iron wire is coiled in the form of a close and continuous helix. As this wire is wound by a machine in the form of a continuous coil, just so much of the wire is separated in forming a coil as gives just the proper resistance. These coils are then placed in the groove which runs spirally around the porcelain insulators. Care is taken to stretch out the coil sufficiently to prevent adjacent spirals of the coil from coming in contact with each other, and contact with that part of the coil in neighboring grooves is prevented by ridges separating the grooves on the porcelain. The result is that the wire is thoroughly insulated, and short-circuiting within the heater itself is prevented, and still it is wound open so as to present its whole surface to the air. It is so arranged, too, by its even pressure upon the porcelain insulator, that no part of this coil can vibrate, and hence there is no danger from the crystallization of the iron wire while hot from tremor or vibration of the heated wire. This feature of this heater is a very important one, as it absolutely prevents the crystallization, and hence breaking of the resisting conductor. These coils have now been operated for over three years, and not one coil has given out or has shown any oxidizing effect in the substance of the wire. The use of iron as a resisting conductor obviates the difficulties of crystallization to which German silver is especially liable. The melting point of iron is at a temperature of nearly 3,000° F., so that the temperature of fusion is so far above the normal temperature of the resisting conductor, and as vibration of conductor is prevented by the method of winding it on the insulator, no danger occurs from oxidation, fusion or crystallization.

It is important in the construction of electric heating devices that the expansion of the metallic wire due to change of temperature be fully provided for, and that the heater be so arranged that under no circumstances can the force of expansion and contraction create a strain upon the resisting conductor or upon the insulating parts which would be liable to injure or to break them. This is especially important in conductors designed to be run at a high temperature, as the difference in length of the conductors at the extremes of temperature to which it is subjected is quite a considerable part of its length.

It is a well-known principle that a wire of a given length, if heated and then cooled, and again heated and cooled, is not the same length at the same temperature that it was in the first test. Changes will go on for some time in lengths of wires so subjected to heating and to cooling. On the other hand, care must be taken that under no conditions can the expansion of the wire make it loose on the insulator, and so cause a short circuit between neighboring wires. In a car equipment of the heaters just described, the length of wire, when heated to the highest temperature to which it is subjected in the regular operation of the heater, is 7 ft. 5 ins. longer than it is when cold. By the construction adopted, this expansion is taken up between consecutive layers of the wire itself, so that expansion and contraction of the wires do not operate to vary the tension of the coil of wire, nor even to vary the pressure with which it binds the insulator itself.

The change of temperature in resisting conductors is attended with other phenomena, which should be considered in the construction of electric heaters. For example, it is well known that the resistance of a wire of a given material of given length and cross-section depends upon the temperature at which the resistance is measured. Iron wire possesses certain qualities in its variation of resistance with temperature which admirably fits it for use in electric heaters. An iron wire having a resistance at 0° C. of 100 ohms has its resistance doubled when the temperature is increased to 180° C., and its resistance is increased to 500 ohms when its temperature is 525° C. The change of resistance in German silver is but a fraction of the change of resistance of iron wire.

The application of this favorable resistance in the construction of an electric heater is the automatic control which this property of iron wire gives over the temperature of the electric heater itself. If a non-conducting hood is placed over an electric heater which prevents the circulation of air, the escape of heat will be prevented, and the temperature raised to a dangerous extent.

The use of the variable resistance, so marked in iron wire, is apparent, as its effect is to reduce the amount of current flowing through the heater, and hence to reduce the amount of heat generated. Two electric heaters, one of iron wire and the other of German silver, both having the same resistance at 0° C., and both being covered with a non-conducting hood, which prevents the escape of heat, would, as the temperature rises, act very differently. If the temperature rises to 300° C., only two-fifths as much current would pass through the iron resisting wire as passes through the German silver. This throttling action of the iron wire increases more rapidly even than the increase of temperature, so that at 600° about one-fifth as much current passes through the iron wire as passes through the German silver, and in each case the reduction in current means also a reduction in the amount of heat generated. A heater, therefore, provided with an iron-resisting conductor has this advantage over that fitted with German silver, that if for any reason the escape of heat from an electric heater is prevented, either purposely or accidentally, the action of the rise of temperature upon the heater itself is to so throttle down the amount of current passing through it (and hence the amount of heat generated) as to prevent such a high temperature of heat as might prove dangerous.

Careful tests made with thermometers placed against the grated openings, which the clothing of passengers might possibly touch, show that the highest temperature of the air is about 180° F., owing to the free discharge of air up through the heater.

The proportion of electric energy transformed into heat in a conductor depends upon the resistance of the conductor. The electric heater is the only case that comes within our knowledge where 100 units of electric energy may be transformed into 100 units of any

* Abstract of a paper read at the annual meeting of the New York State Street Railway Association, held at Albany, N. Y., Sept. 17.

other one form of force. We can then establish the heat equivalent of the electric current for all electric heaters in which no disintegration takes place in the resisting conductors, one B. T. U. being produced by 1,047 watts of electric energy. We are constantly meeting with business men, as well as so-called inventors of electric heaters, who claim that some particular form of electric heater which they have devised will produce a greater amount of heat per unit of electric energy than some other form of heater. This is plainly impossible, so long as neither mechanical motion, chemical motion, light nor magnetism is produced in the electric heater. Transmission of electric energy is, therefore, entirely into heat with an efficiency of 100%. It is true that in some of the forms of electric heaters a chemical action, resulting in the destruction of the heater, is produced by the electric current. Where chemical action takes place, the chemical action can be determined in units of energy; the efficiency, then, of that particular electric heater must be 100%, minus the amount so transformed into chemical action. But, where we have the wires of electric heaters running year after year, without any change of any kind appearing in these wires, it is evident that the efficiency may be regarded as 100%.

It is an easy matter to determine the exact amount of heat which is produced in electric heaters when the consumption of current is known. For example, if we find the number of watts by multiplying the number of amperes passing through the heater by the difference of voltage of the heater terminals, and then divide the number of watts by 1,047, we will have as a quotient the number of British thermal units of heat generated in the electric heater per second. If we consider the electric heaters in a car to be using as a maximum 12 amperes of current on a 500-volt circuit, we will find that 12 amperes of current multiplied by 500 will give us 6,000 watts. Dividing 6,000 watts by 1,047, we obtain 5.73 B. T. U. of heat generated in the car per second. Multiplying 5.73 by 60 will give us 343.8 B. T. U. per minute.

Practical experience in the heating of cars has demonstrated that it requires about 20,000 B. T. U. per hour to properly heat an 18-ft. car in the latitude of New York state in the coldest weather, which amount of heat should be provided as a maximum. The average requirement during the winter months, when heat is used, would not exceed half this amount, or would be, approximately, 10,000 B. T. U. per hour. The amount of heat required, however, differs somewhat according to the construction of cars, to their exposure to winds on the line where they are run, and to the care exercised by conductors in closing the doors promptly when passengers enter or leave the cars. All of these are points which affect materially the temperature which will be maintained in a car with a fixed amount of heat. Also the number of people in a car affects quite perceptibly the amount of heat required. Crowded cars require less heat to maintain a given temperature than is the case with cars carrying but few passengers, due to the amount of heat given off from the bodies of passengers. Experiments made as to the effect of passengers upon the temperature of cars and houses have shown that each person gives out 191 B. T. U. of heat per hour. When we compare this amount with the average amount of heat required during the cold weather, we find that the heat given out by 52 persons will maintain the same temperature in the car as it is required on the average during the winter months. This point has a practical bearing in the heating of cars in that, if a car is heated uniformly, as with a stove, it would be found over-heated during these hours of the day when the cars are filled with passengers. When electric heaters are used some roads have established the practice of reducing the heat between certain hours when their cars are filled with passengers. This would still allow a comfortable degree of heat to be maintained in cars, and at the same time would allow the use of the extra power for propelling cars at the time when travel is the heaviest. The next point in regard to electric heating is the regulation of temperature. As the temperature of the outside air during the heating season will vary from 50° to — 15°, it is important that the electric heating apparatus be so constructed that the amount of heat given to the car varies so as to meet the demands of the variable weather. This is necessary for two reasons: First, it is necessary in order to maintain a comfortable temperature in the cars with variable conditions in the weather; and, second, it is important in order that the consumption of current shall be adjusted to the actual demands. Undoubtedly a great saving in the use of current is brought about by the use of apparatus that is provided with means for proper regulation.

A device introduced for the purpose of regulating the temperature of the cars, and by which five different intensities of heat may be obtained, corresponding to consumptions of current varying from 2¼ to 12 amperes, operates by shifting the heating coils constituting the car equipment, into series and multiple series, so as to vary their combined resistance, and hence to vary the flow of current through them. On small cars and in climates where comparatively a small amount of heat is required, an equipment consisting of four heaters is often used instead of six, as is the standard equipment. These four heaters are connected up with a three-point switch, which is so arranged as to place the heating coils in multiple or in series, so as to vary the consumption of current from 2½ to 8 amperes. The cost of heating cars by electricity is determined by the cost and quantity of current consumed. If the number of ampere hours on a 500-volt circuit can be once determined, and the cost of an ampere-hour on the same circuit is known, the cost of running electric heaters can be readily ascertained. The question of cost, however, is not easily determined, as it still remains an open question as to just what items should be charged to electric heating. It would be but fair for a company considering the advisability of introducing electric heaters in their cars to consider, not the total proportionate cost of current consumed, but rather the additional cost of generating the current to supply the electric heaters, not charging to electric heaters such power-house expenses as would continue the same, provided electric heaters were not introduced, but only the cost of the additional current. These costs have been carefully determined, based upon the cost of producing power by different types of engines, as contained in a paper by Dr. Charles E. Emery, in the "Transactions of the American Institute of Electric Engineers" for March, 1893. From this it will be seen that the cost of operating electric heaters will depend upon the kind of engine employed and the cost of coal. For example, if coal costs $2 a ton of 2,000 lbs., and if the average consumption of current in cold weather is seven amperes, and if we take a compound low-speed condensing engine as the average type of engine in point of economy in consumption of fuel, we will find that seven amperes for one hour will cost 1.17 cts.

From the reports received the average length of time a car is in service per day in the winter is shown to be 15 hours. The cost of operating electric heaters, with the average consumption of current in cold weather, would, therefore, be 15 times 1.17 cts., which equals 17.55 cts. for 15 hours. This cost does not allow for any depreciation in heaters, as the three years of service of the heaters here considered does not appear to have any effect upon the life of the conductors, and not a single coil in any heater has ever been renewed in this length of time. So far as examination of the coils that have seen three years of service can determine, absolutely no oxidation has been produced upon the wires. Some allowance, however, should be made for repairs, when the amount of necessary repairs can be ascertained.

As to the cost of heating by stoves, a number of reports have been received from different railways in New York state using stoves. The list of questions submitted was designed to bring out as full information as possible in regard to the operation of cars equipped with these stoves. Several roads furnished reports, and where quantities are mentioned the figures given below are the average of the quantities stated in these reports.

Taking the average made in the answers referred to, it was found that 33 lbs. of coal were used per car per day, costing $4.55 per ton of 2,000 lbs. This coal costs 7⅓ cts. per day. The average cost of repairs per car is ⅓ ct. per day. The average cost of dumping fires, removing coal and ashes before car is run out of barn, and coaling up and rekindling fire in the morning, including the cost of kindling used and that part of cleaning cars chargeable to stoves, is 10 cts. per day. The average cost per day of other expenses chargeable to stoves not included in above, such as cost of removing stoves for the summer, installing of the stove in the autumn, repairing headlinings, repainting, etc., averages 1¼ cts. per day. Without adding anything to the cost of the stove for the space for one person occupied by the stove, the total of the items so far aggregates 19¼ cts. per car per day. It has already been stated that the extra cost of current based upon the cost of power necessary to heat a car with seven amperes of current on a 500-volt circuit aggregates 17.55 cts. per car per day. This amount will be modified as different types of engines are used; for the type of engine generally used it is correct. Other questions of greater importance enter, however, than the cost of the mere heating by electricity or stoves, such as the effect which electric heating has in inducing travel upon street car lines. It is, however, a difficult thing to determine in figures exactly what increase of travel takes place, on account of having cars properly heated at all times, and that heat being properly distributed through the car. This point is worthy of the consideration of managers of street railways in the matter of securing patronage for their lines.

The following is a summary of answers sent in reply to a series of questions regarding heating: Fire started, Nov. 15; discontinued, March 24. Coal consumed per stove per day between dates mentioned, 26 to 38 lbs.; average, 33 lbs. Cost of coal per ton, $4.25 to $5; average, $4.55. Number of hours fire is maintained per day, 17 to 24. First cost of installing stove, including smokepipe, smokejack, etc., $22 to $25; average, $23. Cost of repairs per car per year to maintain stove in working order, 17 cts. to $1; average, 59 cts. It was stated in regard to the average cost per day of dumping fire, removing coal and ashes therefrom, before car is run out of barn, coaling up and kindling fire in the morning, including cost of kindling used and that part of cleaning car due to stove, that in some cases the work was done by watchman without extra cost, and in other cases it was 20 cts. per day; other expenses per day not chargeable in the above, as removing stove in summer, installing in winter, repairing headlinings, repainting, etc., were said to be not over $3 per year per car. Seating space occupied by stove was said to range from that required by one person to 19 ins. No objections were found by persons sitting next to stove. The replies to the question whether the heat was evenly distributed were: "Warmer in the center," "Fairly" and "Very little complaint." In answer to the question whether, if the stove occupied space of two persons this seating capacity should be charged to the stove, two companies answered "No," and another replied, "Space of one person should be charged." The question whether dresses had been burned was answered in the negative. Three companies answered in the negative the question whether headlinings and other part of car had been renewed on account of damage from the stove.

## CHICAGO MAIN DRAINAGE CHANNEL.

### XX.

### Administration.

The successful prosecution of an enterprise like the Chicago Drainage Channel depends much upon a comprehensive and vital executive system. This fact was at the beginning recognized by the Trustees of the Sanitary District, and almost their first labor was to formulate rules governing their own proceedings and systematizing the duties of the subordinate officers of the District. In the following paragraphs the organization and operation of this executive system, as it now exists, will be briefly described.

The law under which the Sanitary District was organized placed the management of its affairs in the hands of a board of nine Trustees, who were empowered with complete jurisdiction in all matters. These trustees were to be elected to office by popular election by the voters in the Sanitary District, and to hold office for a term of five years. The law further provided that there should be a Chief Engineer, Attorney, Treasurer and Clerk to the District, but placed the appointment of these officers in the hands of the Trustees. Altogether the Sanitary District is one of the most independent civil corporations in the political system of this country, a corporation answerable to no other authority than the law which created it. It is a credit to its Trustees that the trust thus imposed upon them has been in no way violated. Mistakes have been made, it may be, but never has there been a smirch upon the honesty and faithfulness of their actions.

For the purpose of administration the Board of Trustees is divided into seven committees—viz.: (1) Judiciary; (2) Finance; (3) Rules; (4) Engineering; (5) Health and Public Order; (6) Federal Relations, and (7) Labor. Any question of administration coming before the Board is referred to the proper committee, which reports upon it with recommendations for such action as seems called for, but the vote of the whole Board determines the action to be taken. In other words, the system of our Federal Legislature for facilitating legislation is closely followed, but the duties of the Trustees do not stop with legislation, as do those of Congress. They are executives as well as legislators, and after legislative action is once taken they must put it into execution, and to this end proper executive departments had to be organized.

The executive departments are five in number, as follows: (1) Department of Construction; (2) Department of Law; (3) Clerical Department; (4) Treasury Department; (5) Police Department. Each of these departments is required to report regularly to the Board of Trustees on all matters relating to its particular work. The organization and work of the different departments will be described briefly.

Engineering Department.—The Engineering Department is in charge of the Chief Engineer, Mr.

Isham Randolph, who is responsible only to the Board of Trustees, and for the purpose of administration, it is divided into four divisions, as follows: (1) Division of Construction; (2) Division of General Engineering; (3) Division of Maps, and (4) Division of Records.

Division 1, or the Division of Construction, is in charge of the Superintendent of Construction, Mr. Uri W. Weston, who has general charge of the work of construction, and reports each month to the Chief Engineer regarding the progress of work and the methods adopted in its prosecution. Under this division there are four subdivisions, each of which comprises the work on a portion of the channel, and is in the immediate charge of a Division Engineer, who has under him the necessary instrument men, computers and assistants. The importance of the work of the Construction Division is sufficiently emphasized by the articles which have preceded. It is upon the estimates of the division engineers that all money for construction is disbursed, and through their reports that the Chief Engineer is kept informed on all details of progress, equipment and management of the work. Estimates of excavation are made twice each month, and the contractors are paid on these estimates.

Division 2, or the Division of General Engineering, is in charge of Mr. Thos. T. Johnston, Assistant Chief Engineer. The work of this division is quite varied, and includes the preparation of plans for structures, the calculation and determination of all questions pertaining to the hydraulic problems met with in the work, surveys and estimates for all work to be done, the testing of material, floor measurements, etc. The field work of the division is in charge of Mr. A. C. Schrader, Assistant Engineer.

Division 3, or the Division of Maps, is in charge of Second Assistant Chief Engineer Edgar Williams, and here all the maps pertaining to the work are prepared, and computations of lands taken for right of way made.

Division 4, or the Division of Records, is in charge of the Record Clerk, Mr. Wm. Trinkaus. Its duty is to keep all the records, accounts, correspondence and documents of the engineering department.

While each division is in a certain sense independent of the others, they all work in harmony for the best interests of the department as a whole. The total force employed of course varies somewhat from month to month, but a fair average is probably about 130 men.

Law Department.—The duty of this department, as its name indicates, is to administer the legal affairs of the Sanitary District. The chief officer is the Attorney of the Sanitary District, who is assisted by an Assistant Attorney and such clerks as are necessary. Mr. George E. Dawson is the present incumbent of the Attorney's office. To the Law Department are referred the various claims and demands which are constantly being made; claims by owners of property adjoining the right of way of the District for damages to land; claims by contractors for reclassification of material, for work claimed to be extra, for profit for work called for under the contract, but which the District does not admit, and a great variety of others. The department is also called upon to collect and sift the evidence in all complaints made by employees, suppliers of material, machinery, etc., who request the intervention of the District toward the settlement of the disputed matters. Routine matters of this character occupy much the greater share of the department's time, especially at present, when questions of right of way have been nearly all settled.

At first the most important work of the department was the acquirement of the right of way. Of the total 6,453.63 acres of land secured up to Jan. 1, 1895, 2,285.66 acres had to be obtained by condemnation. As the right of way was made up by the aggregation of numerous small tracts having different owners, the number of condemnation suits was very great, and the work entailed correspondingly large. The usual disposition of landowners to make the most of a good thing in cases of this kind was, of course, encountered, but, on the whole, this extortion was kept down pretty well. The total cost of the 6,453.63 acres of land secured at the end of 1894 was $2,371,856.00, or an average of $367.50 per acre.

Clerical Department.—This department is in charge of the clerk of the Sanitary District, Mr. Thos. F. Judge, and, as its name indicates, it has for its duties the general clerical work of the District.

Treasury Department.—The head of this department is the Treasurer of the Sanitary District, and its duties are to receive and disburse all money on the order of the Trustees.

Police Department.—The employment of from 5,000 to 8,000 men by the contractors of the Drainage Canal naturally collected the usual crowd of vicious and idle persons who always flock to live off the improvidence and vice of the more ignorant working men or by petty theft from their employers and the surrounding population. Saloons, brothels, dance halls, etc., sprang up along the work like mushrooms, all bidding for the money of the canal laborers, and crime and disturbance quickly resulted. To protect persons and property from interference by these people, a thorough policing of the work and adjacent neighborhood was necessary, and on July 12, 1893, the Board of Trustees exercised the powers granted them by the drainage law, and passed an ordinance creating a police department. This ordinance provided for the appointment of a marshal, who should administer the affairs of the department under the direction of the trustees, and Mr. Edward Williams was appointed to this office.

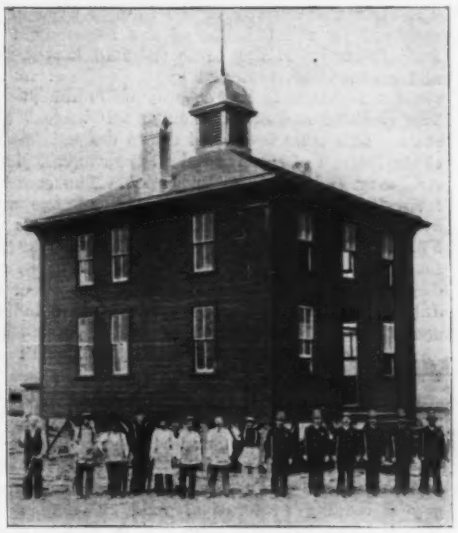


Fig. 89.
Sanitary District Police Station at Lemont.

As now organized, the police force consists of a Marshal, First Sergeant, five Sergeants, 40 patrolmen and a watchman, driver and hostler. This force is distributed over the six districts, as follows:

| | Station. | No. men. |
|---|---|---|
| 1st district, | Hymen Ave. and Ill. & Mich. Canal... | 8 |
| 2d " | Summit ..... | 7 |
| 3d " | Willow Springs..... | 7 |
| 4th " | Sag Bridge..... | 9 |
| 5th " | Lemont ..... | 8 |
| 6th " | Romeo ..... | 8 |

The First Sergeant is stationed at the central office at Sag Bridge, and one Sergeant at each of the other stations. The first and sixth districts each cover about six miles of the canal, and the other four about 4½ miles each.

Each district has a station house provided with living and office accommodations for the men, and having an iron cage in which persons arrested are confined until removal. Fig. 89 is a view of the station at Lemont, Ill., and the others are exactly like it in construction. The accommodations for the men are plain but serviceable, and the station houses present a neat appearance. The men are uniformed in dark blue, with dark drab helmets, and have the usual equipment of metropolitan police for enforcing authority. Eight horses and four patrol wagons are used for conveying obstreperous prisoners and for other necessary purposes of the department.

The work of the police department is quite varied. A population of nearly 8,000 people lives upon the work, and machinery and tools to the value of some $2,000,000 are exposed to damage in case of a serious disturbance. As few of the contractors employ watchmen, this plant has to be watched constantly. The railways paralleling the work are patrolled, and incoming trains are watched to ascertain what vicious characters find their way into the District, and to prevent annoyance to passengers from such people. This is an important part of the work. Freight trains have been taken from tramps; obstructions have been repeatedly removed from the main tracks, and fires on the railways' right of way have been extinguished. Besides this class of duties there are arrests to be made for the crimes and disturbances which occur daily. Assault, drunk and disorderly conduct, carrying concealed weapons, vagrancy and theft are the common offences, although the more serious crimes of murder and robbery are not infrequent. In 1894, 14 arrests were made for murder and 57 for burglary and robbery. It is a good commentary on the efficiency of the force to say that in 1894 only two serious crimes were committed for which the perpetrators were not arrested.

Labor, Wages and Cost of Living.—While not a part of the administration system proper, the character of the labor, the wages paid and the general welfare of the laborers have been closely watched by the Board of Trustees, and largely through their influence the payment of labor on the channel has been considerably above the general market price. Not only have fair wages been secured, but the wages of all classes have been raised to a common standard, the Italians and Polanders being paid the same as the other men, and the importation of cheap labor prevented. For the most part the contractors have showed a disposition to meet the wishes of the Trustees in paying fair wages and treating their men justly.

A great variety of nationalities are represented among the common laborers, but the mechanics, machinists and other skilled laborers are nearly all American-born citizens. Colored laborers are worked on a number of sections, generally in small proportion to the whites, and when properly managed have proved efficient. Their greatest fault is their reluctance to work more than a part of the time, and a quite general refusal to live in common boarding barracks. They prefer to live together in small parties, lodging in separate shanties and small boarding-houses. The white laborers are mostly Irish, Swedes, Austrians, Italians and Polanders, very few Germans and Anglo-Americans being employed. Like the negroes, they are disinclined to work steadily. Indeed, a large proportion of the common laborers do not pretend to work more than just enough to earn their meager living expenses, and they come and go as it suits their convenience. It is curious to note that this class is composed mostly of native-born men, the immigrants generally attempting to work steadily. All nationalities work together, and without race wars or much trouble other than an occasional free fight.

All but a comparatively small number of the employees on the canal are paid by the day, the average wages running about as follows:

| | | | | | |
|---|---|---|---|---|---|
| Laborers | $1.50 to $1.75 | | Firemen | | $1.75 |
| Teamsters | 1.50 " | 1.60 | 1st levermen | | 2.20 |
| Drillers | 1.75 " | 2.00 | 2d levermen | | 1.50 |
| Trainmen | 1.75 " | 2.00 | 1st hookers | | 1.75 |
| Channelers | 2.50 " | 3.00 | 2d hookers | | 1.50 |
| Blacksmiths | 2.50 " | 3.00 | Riggers | | 2.25 |
| Machinists | 2.00 " | 2.50 | Cableway repairers | | 2.25 |
| Carpenters | 2.00 " | 2.25 | Boiler makers | | 3.50 |
| Stonemasons. | 3.50 " | 4.00 | | | |

The salaries of the men employed by the month average about as follows:

| | |
|---|---|
| Superintendents | $100 to $150 |
| Timekeepers | 50 " 100 |
| Bookkeepers | 90 " 125 |
| Foremen | 90 " 80 |
| Pumpmen | 50 " 80 |
| Electricians | 75 " 90 |
| Civil engineers | 90 " 100 |
| Steam shovel engineers | 125 |
| Steam shovel cranemen | 90 to 100 |

During the summer months of 1895 about 8,700 men were employed, of which 1,700, or 19½%, earned $2 per day or more, and 7,000, or 80½%, earned from $1.50 to $1.75 per 10 hours. For shifts longer than 10 hours the men are usually paid pro rata for the extra time.

The number of men employed and the sparse

population along the line of the canal for most of its length, make the securing of board for the workmen in farmhouses or villages out of the question. Most of the contractors have erected boarding barracks or camps on their work. Sometimes the contract is let to outside parties to run these camps, but many of the contractors have a commissariat department of their own. Board in the camps is from $4 to $4.50 per week. About two-thirds of all the employed men—mostly single men—board in the camps. The married men live with their families in huts, cabins, tents and cottages along the channel, paying a mere nominal rent to the contractors who erected these dwellings. Neither from these rentals nor from the boarding camps do the contractors make any money.

On most sections there are commissary stores for the accommodation of the working men, where they can get tobacco, clothing, boots and whatever else they usually require. These are not, however, truck stores, such as have been prohibited in Pennsylvania and other states. The workmen need not buy there in order to keep their jobs, they are not charged more than in ordinary country stores, and they can buy on credit for themselves and family.

Most of the contractors have arrangements with certain hospitals by which their employees are treated in case of sickness or accident, each employee being required to contribute 50 cts. per month to the hospital fund, and in return for which he is treated free of all expense. In some cases regular physicians are employed by the contractors. As a general thing the health of the men is good, although bruises, sprains and sometimes more serious accidents occur daily.

Despite the good wages and the reasonable cost of living, the laborers save little money, the more ignorant of them being extremely improvident and childish in their expenditures. No small proportion of their surplus earnings goes into the liquor saloons, gambling houses and other vicious places, although it would be a mistake to say that the laborers as a whole are habitual frequenters of such resorts.

## GARBAGE COLLECTION AND DISPOSAL AT PITTSBURG, PA.

The city of Pittsburg, Pa., passed in January last an ordinance (No. 254) providing for the collection, removal and disposal of garbage, offal, dead animals and condemned meat, and authorizing the Bureau of Health to enter into a contract for this purpose. According to this ordinance "garbage and offal" include any refuse accumulation of animal, fruit or vegetable matter, liquid or otherwise, that attends the preparation, use, cooking, dealing in, or storage of meats, fish, fowls, fruit or vegetables. This material must be placed in watertight vessels or tanks, not exceeding 2 bushels capacity, these vessels having handles on the outside, and close-fitting covers which must not be removed except when necessary. The vessels must be ready when the scavenger or collector calls at the time stated by printed notice, and it is unlawful to place in the vessels any ashes, paper or other refuse materials than those above enumerated, with the exception of tin cans. Neglect or refusal to have the garbage ready for the scavenger at the time and in the manner mentioned in the printed notice involves a penalty of $5 for each day that the material remains after having been called for, and it is made the duty of every resident, householder, tenant, hotelkeeper, boarding-house keeper, retail dealer, etc., to provide and keep in use the garbage vessels above mentioned.

Persons engaged in collecting and removing garbage—that is to say, the contractor or contractors for such work—are required to provide iron or steel boxes or wagons on two or four wheels, made perfectly watertight, and securely covered at the top, so as to prevent the escape of the contents or any odor therefrom, and when emptied each wagon must be thoroughly washed and disinfected. The contractors' men, with the wagons, must call regularly at all hotels, restaurants, boarding-houses, dwelling houses and retail dealers' at the time provided, giving warning of their approach by sounding a horn at each street corner and the middle of each block. The contract for collection does not include stock yards, slaughter houses, meat shops, stables or the warehouses of commission merchants dealing in meats, fish, fowls, fruit or vegetables, but the owners or occupants of such places must remove at their own cost to the disposal plant all garbage, offal and dead animals from these premises with the same frequency and in the same manner as above described. Persons removing dead animals and condemned meat must use iron or steel wagons similar to those used for garbage removal, and the term "dead animals" is specified to include all dead, undressed, unslaughtered hogs, cattle or other animals which may have died from disease, accident or other cause.

Proposals for the work were advertised for, bidders being required to conform to the following provisions: (1) To furnish a certified check for $10,000 to have the necessary equipment by July 1, 1895; (2) to state the gross sum of money asked for the performance of the work in all the five districts into which the city was to be divided; (3) to specify the character of the furnaces they proposed to use, and further, to specify that such furnaces had been in successful sanitary operation in some city in the United States as a garbage furnace for a period of at least two years past. The contractor was required to build, equip and operate in each district a plant or furnace of sufficient capacity for the disposal of all garbage from that district, but this was subsequently changed to permit of the establishment of one central plant. The style and capacity of the furnace were to be approved by the Director of the Department of Public Safety. It was to be operated in a proper and sanitary manner, and guaranteed not to become a nuisance to any locality or to the public. The cleaning and disinfection of the wagons and storage bins must be carried out to the satisfaction of the Bureau of Health, and all the wagons, plant, etc., must be subject to inspection. The contract for collection and disposal of the garbage was awarded on March 5, 1895, to Mr. Charles E. Flinn, of Pittsburg, Pa., at $79,890 per year for four years, including the erection of the necessary disposal plant. This contract went into effect on July 1, and the collection system is now in full operation, but the erection of the disposal plant has been delayed, and it was only in partial operation at the end of August.

The city is divided into five districts, and the contract specifications require the garbage to be collected daily, except Sunday, during the seven months April to October, inclusive, and on Tuesday and Saturday, or Tuesday, Thursday and Saturday (according to location) from November to March. The service is from 2 a. m. to 6 p. m. at present, work being commenced thus early in order to have the garbage removed from all the hotels and restaurants before breakfast time, so as to avoid any nuisance by sight or smell. The city has a population of 275,000, and there are approximately 50,000 houses in the city, and the men are supposed to go into them all; but, of course, in many of the poorer districts, there are few garbage cans are kept. On an average, two collections a week are made from each house, but a wagon is sent whenever a complaint is made, or when notice is given of an extra quantity of garbage, as in the case of a reception, etc. Great care is taken to prevent houses from being skipped or missed, and when a complaint is received it is recorded at the office, and the inspector of that district notified, the inspector then filling up a blank "complaint record" and sending a wagon up to the house. In many cases it is found that the complaint is a mistake, the people having mistaken the day on which the wagon calls, or the head of the house making a complaint in the city that the garbage had not been removed when he left the house, when very likely he left before the time when the wagon was due. The nature of the complaint is stated on the blank, and the driver of the extra wagon sent in answer to the complaint notes on the blank whether it was a real complaint or a mistake on the part of the people of the house. The number of complaints per day was at first from 7 to 15, but is now only 2 to 5, which is a very good record, especially when it is remembered that this includes the mistaken complaints. The form of the complaint card is given below, the actual card being 6¼ × 3¾ ins.

COMPLAINT RECORD. No.....
Ward.... Pittsburg, Pa.....189..
Name .....
Residence .....
Wagon No..... Driver.....
Remarks: .....
.....
.....

Very few of the complaints are of a "cranky" character, and the people are said to be very obliging and willing to comply with the requirements, being well satisfied with the service, and realizing the improvement of this system upon the old plan, by which each house or store hired individual garbage removers. These small contractors had often a scattered patronage involving long journeys between the houses served, and the cost was from $2 to $7 a month, according to quantity removed, while under the new system the average tax is about $1.35 per year for a household. There was some little trouble at first with people not sorting the house refuse properly, and putting ashes, waste paper, etc., into the tanks, but they very soon became educated up to this, especially as the contractor refused to take such material, so that it was made plain to the people just what would be allowed as garbage.

There are five inspectors, one to each district, and each inspector has from four to eight carts under his direction. These men are on their rounds during the day, and call up the contractor's head office by telephone (frequently using the telephones in the houses) two to five times a day, to know of any complaints. They make a final call over the telephone about 3 p. m., and all report in person at the office at 5 p. m. If a complaint of garbage not removed is received before 10 a. m., the wagon can call before noon, and if received between 12 and 2 p. m. the wagon can still call the same day. An alphabetical list of complaints is kept, so that it can at once be seen if the same house is missed more than once, which would lead to an investigation. Unnecessary delay is sometimes caused by careful householders who are so afraid of having their garbage tanks stolen that they keep them under lock and key in a cellar or outhouse.

The equipment consists of 35 steel wagons, each district having from four to eight wagons, and the wagons for each district are stabled in that district. There are 32 two-horse wagons, the other three being one-horse wagons. Each wagon is mounted on four wheels, and so hung as to be evenly balanced both empty and loaded, so that it can easily be dumped and returned to position. A simple latch locks the body down upon the frame. These wagons were built by the Fulton & Walker Co., of Philadelphia, Pa., and cost $325 each. They weigh 3,000 lbs. empty and carry a load of 4,050 lbs., making the loaded weight 7,050 lbs. As shown by the accompanying cut, the wagons have four close-fitting top doors, two folding back from the rear, and one from each side, immediately back of the driver's seat. The rear lids or doors afford easy and rapid discharge of the load when dumping, and both rear and side doors are used when loading. The men are required to keep these doors closed, raising them only when dumping a can into the wagon. The men are also cautioned against any unnecessary banging of the doors, and are held responsible for any damage due to careless or rough handling of the wagons. The 35 teams and drivers are all hired, most of them from men who were formerly in business as individual garbage collectors, so that the men and horses are used to the work. There are 75 men employed—that is, two men to each wagon and five inspectors. When at work collecting the garbage, the driver collects the cans or vessels from one side of the street or alley, and the helper takes the other side, the horses walking on and stopping according to the driver's calls. Two to four trips are made daily, according to the distance from the disposal plant, the longest haul being about six miles on the street route, or four miles in a direct line. The wagons are cleaned out with a broom and water at the furnace, washed at the stables thoroughly every Saturday and disinfected twice a week. The front of the wagon is provided with a seat for the two men. The wages paid are $1.50 per day for the helpers, $2.50 a day for the inspectors, and $2 to $2.50 per day for the men at the furnace and reducing plant.

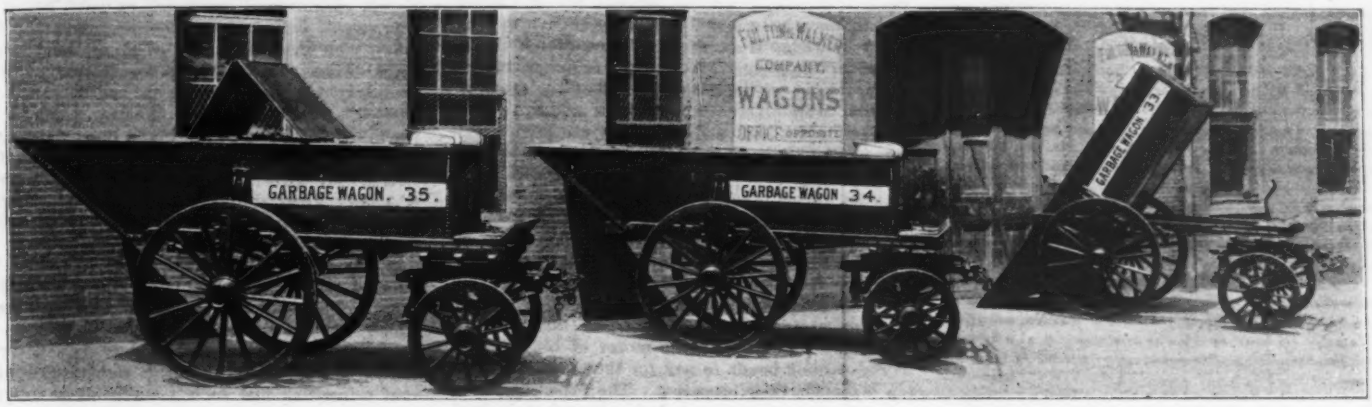
The contract specifications require the contractor to make daily reports to the Bureau of Health, upon blanks furnished by the bureau, setting forth the number of loads of garbage and the number of animals collected in each district. He is also required to furnish monthly reports (under oath) to the City Controller, upon blanks furnished by the Bureau of Health, such reports giving the number of each house and the name of the street, and stating by day and date the number of calls made for garbage at each house during the month. These reports must be filed with the Bureau of Health on or before the fifth day of each month. Payment for the work performed is made in monthly installments upon the regular payrolls of the Bureau of Health.

The system of disposal adopted by the contractor is that of the Consolidated American Reduction Co., of New York city, a local company having been organized at Pittsburg, known as the American Reduction Co., of which Mr. Flinn is President. This system is already in use at Boston, Mass., and Philadelphia, Pa., as described in our issue of March 28, 1895; the garbage is treated by steam in digesters, and then dried out to form a fertilizing material. The garbage is dumped from the wagons into a receiving pit, from which it is raised by chain bucket conveyors, built by the Link Belt Co., of Chicago, and carried to a receiving platform, where cans, etc., are picked out, and it is then carried by another conveyor to the digesters, which are heated by steam jackets, and in which the garbage is treated by live steam at a pressure of about 30 lbs. per sq. in. Water is added if the material is too dry. The water and grease from these digesters are passed through a separating apparatus. The treated garbage is then passed through Anderson driers and fed into a revolving screen, from which the finished product issues as a dark chocolate-colored, granular material, which is almost odorless and makes an excellent fertilizer. The tailings from the screen amount to only about 1% of the product. Tin cans and glass bottles have to be taken by the contractor, but are sorted out before the treated garbage is placed in the driers, as they tend to form balls of the material, the inside of which is not thoroughly treated. Paper is carefully avoided, as when wet it sticks to the digesters and clogs the passages, being very awkward stuff to handle. The quantity of the material dealt with is irregular, as the amount delivered by the commission merchants, etc. (who haul their own refuse to the furnace, as already described), varies from day to day, and some days the amount is considerably increased by large quantities of condemned fruit or canned food. There are ten digesters, with a water tank to each pair of digesters, and the conveyors are operated by a horizontal steam engine, built by the Atlas Engine Works, of Indianapolis, Ind. The plant has a capacity for 100 tons of garbage per day, and the finished product is about 20% of the amount treated. At the time of the visit of our representative, in August, only two of the digesters were at work, and the testing of the boilers and clothing of the boilers and piping had not been completed, but it was expected to have the plant in full operation within a few weeks.

For about six years the city has had in operation a Rider garbage cremating furnace, which has given good results, but is not of sufficient capacity to deal with the city's garbage, having been put in mainly as an experiment. This furnace has been turned over to the contractor, and is kept in service until the new reducing plant is in full operation, after which it will be kept in readiness for use in case of any accident or failure at the larger plant. Complaints have been made from time to time as to odors from this furnace, but it is said that in many cases the odors came from other sources (this part of the city is not a sweet-smelling locality, anyway). At the present time special care is taken to disinfect the raw garbage and to avoid the escape of bad smells from the stack. In the Rider system the garbage is simply cremated, the product being useless. Tin cans are picked out and sold to a man who obtains the solder from them, and glass bottles are also picked out and sold. The garbage is dumped onto a platform above and along one side of the furnace, from which it is shoveled down behind a vertical partition, having openings in line with the 18-in. charging holes in the top of the furnace, there being two rows of seven holes each. For charging any one of the nearer holes, the lid is pulled off with a hook, and a man on the working or charging floor (which is the top of the furnace) hauls the closely-packed garbage down through the opening in the partition with a two-pronged hoe, the stuff falling into the charging hole. For the further row of charging holes the garbage coming through the opening is allowed to fall into a galvanized cylindrical tank or bucket, which the furnaceman empties into the charging hole. Coal was formerly used for fuel, but has been displaced by natural gas, which gives a more intense heat and more rapid combustion of the garbage, which is important in a furnace whose capacity is pushed like that of the one at Pittsburg. The furnace can dispose of 40 to 60 tons of garbage per day, at a cost of about $20 for gas and $12.50 for labor.

At Allegheny, Pa., a Rider furnace has been in use for about six years, and in this coal is still used. It is claimed that the cost per ton of garbage is only 25 cts., but this seems to be a very low figure, and not to be accepted for heavy working.

For information furnished in connection with this article we are indebted to Mr. Wakefield, City Engineer of Pittsburg, and Mr. W. A. Martin, bookkeeper and Superintendent for Mr. Charles E. Flinn, the contractor.




GARBAGE WAGON USED AT PITTSBURG, PA.
The Fulton & Walker Co., Builders, Philadelphia, Pa.

The Chignecto Ship Railway Co. has been granted an extension of time for completion, provided that the company guarantees to furnish a certain amount of traffic before claiming the Dominion subsidy. The original subsidy promised was $150,000 per annum for 25 years after completion, which subsidy was afterwards changed to $170,000 for 20 years. The chief difficulty in the way of completion seems to be the very poor prospect that the railway can secure sufficient patronage to yield an income on the investment required, at the proposed rates of transfer of 50 cts. per ton of cargo and 12 cts. per ton of hull.

Corrosion of the iron bridges over the railway tracks at Baltimore, Md., is said to be serious, owing to the destructive action of the smoke and gases from the engines. The City Council has been asked to make an appropriation to clean and paint the bridges, but no action has been taken.

WEATHER TABLE FOR AUGUST, 1895. (Furnished to Engineering News by the Department of Agriculture.)

| | Stations. | Temperature. (Deg. Fahr.) Average. | Max. | Min. | Range. | Wind. Velocity in miles per hour. Average. | Max. | Direction at time of max. velocity. | Precipitation—rain or melted snow—inches. Total. | Heaviest in 24 hours. | No. of rainy days. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northern Cities. | Northfield, Vt. | 62.9 | 85 | 36 | 49 | 7.5 | 33 | SW | 4.64 | 2.09 | 16 |
| | Portland, Me. | 66.2 | 83 | 47 | 36 | 6.7 | 28 | W | 4.72 | 1.62 | 12 |
| | New York, N. Y. | 73.8 | 90 | 55 | 35 | 10.8 | 62 | SW | 4.12 | 1.17 | 9 |
| | Pittsburg, Pa. | 74.5 | 95 | 52 | 43 | 5.1 | 31 | NE | 4.29 | 1.47 | 11 |
| | Chicago, Ill | 72.4 | 91 | 58 | 33 | 13.2 | 45 | S | 6.49 | 3.65 | 8 |
| | Omaha, Neb. | 74.4 | 96 | 56 | 40 | 7.2 | 30 | NE | 7.18 | 2.20 | 13 |
| | St. Paul, Minn. | 69.8 | 94 | 45 | 49 | 6.5 | 36 | NW | 2.89 | 0.99 | 11 |
| | Duluth, Minn | 65.4 | 85 | 46 | 39 | 9 6 | 36 | SW | 1.67 | 0.48 | 12 |
| | Bismarck, N. Dak | 67 4 | 98 | 32 | 66 | 9.0 | 34 | NW | 0.40 | 0.15 | 5 |
| | Average | 69.6 | 91 | 47 | 44 | 8.4 | 37 | | 4.01 | 1.54 | 11 |
| Southern Cities. | Washington, D. C. | 77.3 | 97 | 54 | 43 | 5.1 | 25 | NW | 1.26 | 0.32 | 9 |
| | Louisville, Ky. | 77.6 | 96 | 53 | 43 | 6.0 | 33 | SE | 1.35 | 0.40 | 8 |
| | St. Louis, Mo | 77.9 | 94 | 58 | 36 | 8.2 | 37 | SW | 2.08 | 0.62 | 6 |
| | Savannah, Ga | 82.2 | 98 | 70 | 28 | 6.1 | 26 | NE | 9.68 | 5.23 | 14 |
| | Kansas City, Mo | 75.3 | 93 | 59 | 34 | 7.0 | 40 | NW | 7 21 | 1.91 | 13 |
| | Jacksonville, Fla. | 82.9 | 97 | 70 | 27 | 6.5 | 34 | S | 2.54 | 0.78 | 16 |
| | Chattanooga, Tenn. | 77.4 | 92 | 59 | 33 | 4.5 | 31 | W | 4.40 | 1.12 | 14 |
| | New Orleans, La. | 81.6 | 92 | 70 | 22 | 6.0 | 30 | NW | 6.79 | 2.67 | 19 |
| | Memphis, Tenn. | 80.0 | 95 | 62 | 33 | 6.9 | 24 | W | 0.64 | 0.41 | 6 |
| | Palestine, Tex. | 82.3 | 98 | 65 | 33 | 4.9 | 20 | SE | 0.06 | 0.02 | 3 |
| | Average | 79.4 | 95 | 62 | 33 | 6.1 | 30 | | 3.60 | 1.35 | 11 |
| Western Cities. | Helena, Mont. | 66.1 | 91 | 40 | 51 | 7.7 | 42 | SW | 0.14 | 0.08 | 4 |
| | Port Angeles, Wash | 56.2 | 88 | 38 | 50 | 6.5 | 36 | W | 0.44 | 0.44 | 1 |
| | San Francisco, Cal | 58.4 | 80 | 50 | 30 | 13.8 | 38 | SW | 0.00 | 0.00 | 0 |
| | Salt Lake City, Utah | 74.8 | 97 | 52 | 45 | 8.6 | 36 | NW | 0.02 | 0.02 | 1 |
| | Santa Fe, N. Mex | 66.3 | 84 | 50 | 34 | 8.6 | 27 | SW | 3.64 | 1.05 | 20 |
| | Denver, Colo. | 70.2 | 91 | 51 | 43 | 6.3 | 33 | NW | 0.76 | 0.31 | 8 |
| | Yuma, Ariz. | 90.9 | 114 | 64 | 50 | 7.5 | 32 | SE | T | T | 0 |
| | Average | 69.0 | 93 | 49 | 43 | 7.6 | 35 | | 0.71 | 0.27 | 5 |

# ENGINEERING NEWS
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The building of three new dry-docks, equal, at least, in size to the one at Port Royal, S. C., is recommended by Commodore Matthews, Chief of the Bureau of Yards and Docks, in his annual report. He would locate these at Boston, Norfolk and Mare Island, Cal., and estimates the cost at $600,000 each. As the "Army and Navy Register" suggests, it is perhaps not so essential where these new docks should be located as that they should be constructed quickly and well, by competent builders. We would add that these ends could be best insured by first reconstructing the Bureau of Yards and Docks, and putting at its head an engineer, who would have authority to advise the Secretary of the Navy as to engineering design and the competency of builders. The experience of the past should teach the authorities that brick masons and political hangers-on are not necessarily dock builders, and line officers of the Navy are not civil engineers, no matter how well trained they may be in their especial calling.

American railway restaurants are not always what they should be; but we have never heard of one receiving a half-million dollars from a railway company to cease its dispensations to hungry travelers. In England, however, the Great Western Ry. has recently paid this sum to the proprietor of a restaurant located at Swindon, on its main line, as an inducement to him to relinquish the contract under which he established the restaurant in 1841 and has since carried it on. It was not, however, the badness of the food and drink offered to its passengers which induced the railway company to "come down" so handsomely; but the fact that the original contract obliged the railway to stop all its trains ten minutes at Swindon. Of course after the lapse of years the company's traffic increased far beyond what was ever dreamed of in 1841, and it has tried again and again to get the agreement annulled, but the courts decided against it, and the purchase price asked was too high. However, the growing competition of the London & Southwestern Ry. has led the company to at last buy out the owners of the refreshment room and many changes will now be made in the schedules of the express trains.

The incident is of interest apart from its merely curious aspect, as a striking example of English ways of doing things, and as a contrast to American customs. If every American railway company were compelled to carry out every agreement which it entered into while its road was under construction—but one can hardly imagine what would have resulted from such a state of affairs, for the corporations which built the railways that have existed for 40 years or more have in almost every case ceased to exist. It is doubtless a fact, however, that contracts are held more sacred over there than here, and their courts are swayed less by public opinion and local influence. Thirty years ago a private individual of small means who had a suit against a railway would take anything the railway would offer him rather than continue in the courts. At the present day the situation is reversed, and it is the railway company which often despairs of obtaining justice.

Numerous irrigation works and projects in the West have been abruptly checked in their development by a recent decision to the effect that the famous Wright Irrigation District act of California is unconstitutional. This decision was rendered by Judge Ross, of the United States Circuit Court of California. According to press reports it was based on the assumption that the great irrigation works planned, and in a number of instances carried out, under this act are private and not public works, using the word public in the sense of benefiting all property in the district. The decision affects other Western states, a number of which have recently authorized the formation of irrigation districts on the California plan. The essential feature of the California law is that it permits the freeholders of "lands susceptible of one mode of irrigation from a common source and by the same system of works," by a two-thirds vote, to organize a district with the power of constructing works, issuing bonds to pay for the same and levying taxes for their operation. The expenses incurred, including the interest on bonds and their final redemption, are met by all the property in the district. The boundaries of the district are subject to the approval and change of the County Board of Supervisors, after a public hearing, but must not include land not susceptible of irrigation from a common system. After the works are constructed each property owner is entitled to water for irrigation in proportion to his district assessment, but he may assign a part or the whole of his water rights. How closely Oregon, Washington, Kansas and the two Dakotas have followed California in framing their irrigation district laws we cannot say. The California act has been confirmed repeatedly by the highest courts of California and the Nebraska act is now being tested in the courts of that state. The California case will doubtless be carried to the highest United States court.

These irrigation district laws have been popular measures, for they afford irrigators a water supply practically under their own control, furnished to them at cost. Without such a system the majority of irrigators are dependent upon water companies for their supply, and often feel, whether rightly or not, that they are unfairly treated, both in the matter of service and water rentals. On the other hand, many of the water companies, for obvious reasons, are unfavorable to these districts, and from them has come some of the strongest opposition yet manifested.

As to the legal aspects of the case, these must be left to the lawyers and the courts. We may say, however, that it is difficult for a layman to see why works constructed by these irrigation districts are not as much public in their character as a municipal water-works system. In either case there may be many taxpayers opposed to the expense of constructing and operating the works, but it has long been held that a city water plant is a public work and it seems equally obvious that these irrigation works should be considered in the same light.

## CONTROLLING THE LEVELS OF THE GREAT LAKES.

Through the courtesy of Hon. Daniel Lamont, Secretary of War, and Col. Wm. P. Craighill, Chief of Engineers, U. S. A., we are enabled to present to our readers with this issue the full report of the recent Board of Engineers appointed to report upon the effect which the Chicago Drainage Canal will have on the level of the lakes. Although brief extracts and somewhat misleading summaries have been published by the daily papers, our presentation with this issue is, we believe, the first time that the full report of this board has been made accessible to the public.

We also give in this issue a brief prepared by Mr. L. E. Cooley, M. Am. Soc. C. E., one of the Trustees of the Sanitary District of Chicago, upon this subject, which was one of the important documents submitted to the Board. Mr. Cooley's paper discusses the subject in an exceedingly interesting manner, and is so broad in its scope and fair in its treatment that it must command the respect of those who are most fearful on the lake level question. Chicago is fortunate, indeed, in having its case so ably presented.

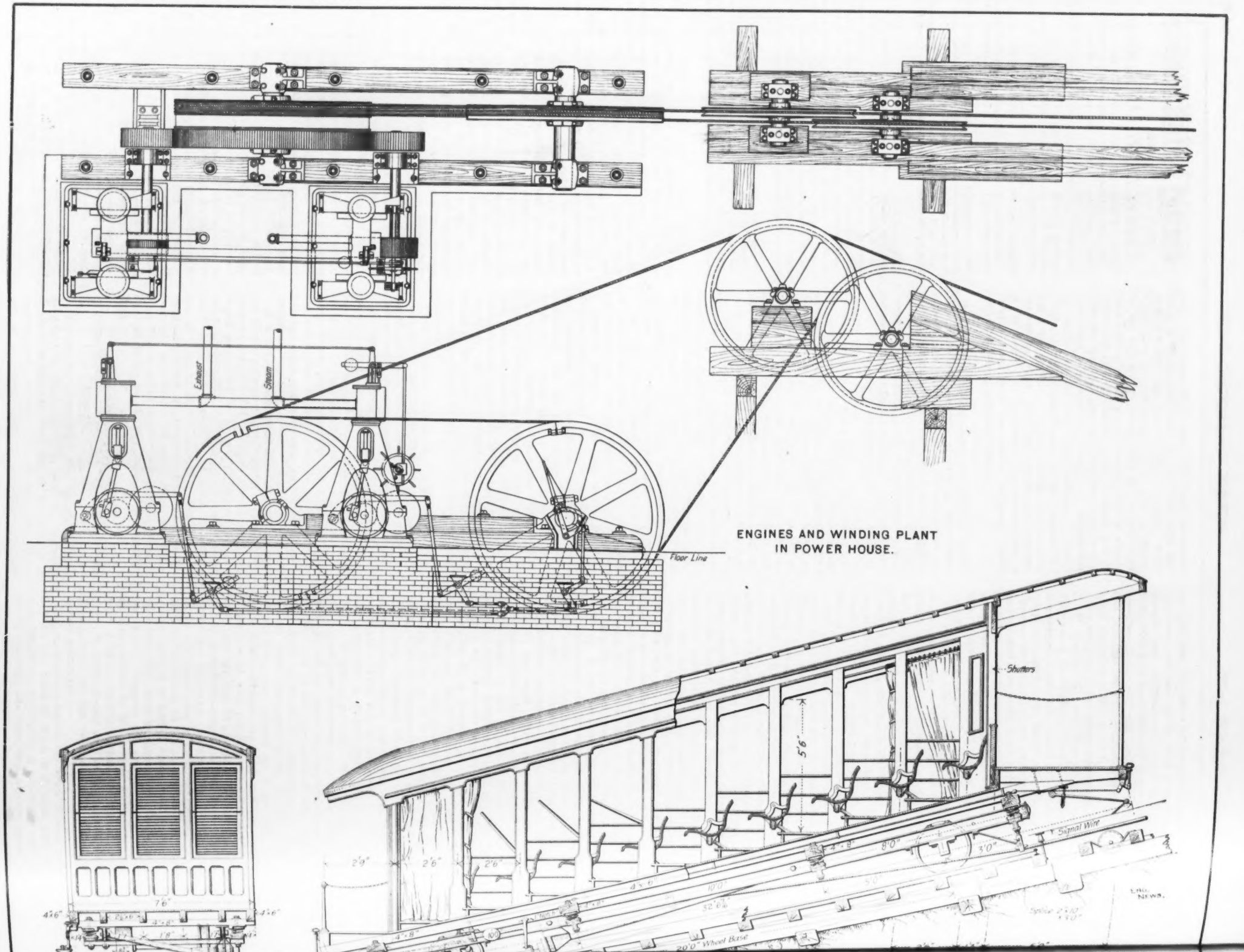
On the other side of the case, we wish to call special attention to the letter of Mr. Cecil B. Smith, of Montreal, published on page 203 of our last week's issue, which presents briefly the Canadian view concerning the effect of the Drainage Canal upon the St. Lawrence canals, of which comparatively little has been heard in the discussions thus far carried on, but which is emphatically deserving of a fair and impartial hearing.

The engineering questions and legal questions which have grown and are likely to grow out of Chicago's great drainage ditch are of absorbing interest, because to a large degree they are entirely unprecedented. Never before in the world's history has any work of man been carried out that affected the water line on four thousand miles of shore. The endless contentions and disputes to which riparian rights have in all times given rise are well known, but past history has never recorded a question of riparian rights affecting so vast a territory and such a multitude of interests.

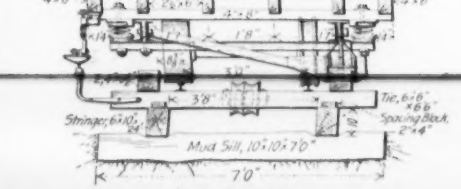
Chicago is making a new outlet for the Great Lakes, and will set flowing through it a river eight times as large as the low-water flow of the Merrimack at Lowell, and four times as large as the low-water flow of the Ohio at the junction of its two branches at Pittsburg. The ultimate flow of 10,000 cu. ft. per sec. through this channel will be in round numbers 15 per cent. of the entire outflow of Lake Michigan; it will be about 4 per cent. of the outflow of Lakes Superior, Huron and Michigan combined, and about 3½ per cent. of the flow in the St. Lawrence. These percentages are based on the best figures which are at present available for the discharge of the St. Clair, Niagara and St. Lawrence rivers. Future and more accurate measurements of these discharges may change the percentages by a fraction of 1 per cent. either way. They can hardly do more than this.

Supposing for the present the outflow of the Drainage Canal to be 4 per cent. of the flow in the St. Clair or Niagara river, it is manifest that their average discharge when the Drainage Canal is set running will be 4 per cent. less than it is at present. What will be the effect of this 4 per cent. reduction in outflow upon the level of the lakes? To give an accurate answer to this question, an extended discussion of river hydraulics is essential; but an answer of approximate accuracy can be given by any one endowed with commonsense and a knowledge of arithmetic. If the volume of water discharged by the St. Clair River, for example, were reduced by 4 per cent, then if the width remained the same and the velocity of the current were constant, its depth would be 4 per cent. less than at present. The depth of this river, it is manifest, determines the level of Lakes Huron and Michigan. In speaking of the depth of the river reference is made, of course, to its depth at the outlet, at the point where the cross-section narrows to such a degree that changes in the cross-section have an appreciable effect on the lake levels. Suppose the average depth of the St. Clair outlet to be 20 ft. Then, as 4 per cent. of 20 ft. is 0.8 ft., the river surface at this point would be 0.8 ft. lower if only 96% as much water were flowing in it, and the width and cross-section remained unchanged.

But, as every one knows, the width of every river becomes less when its depth is reduced, and, still more important, its velocity is materially reduced. Every one who has ever seen a river, great or



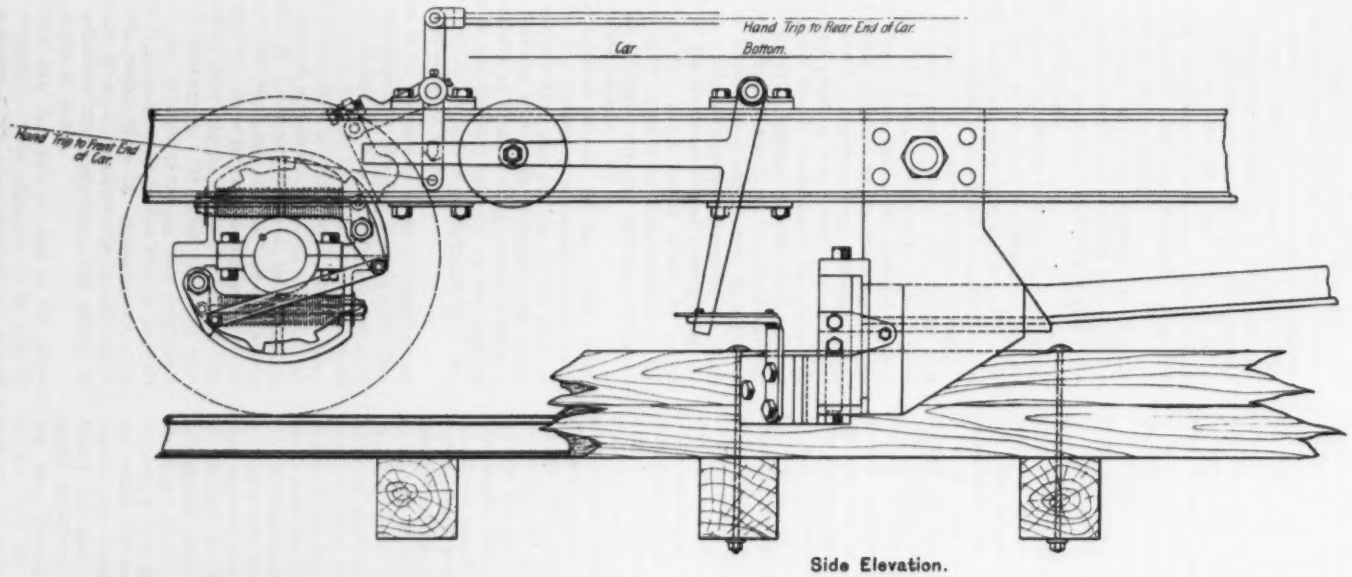

ENGINES AND WINDING PLANT
IN POWER HOUSE.



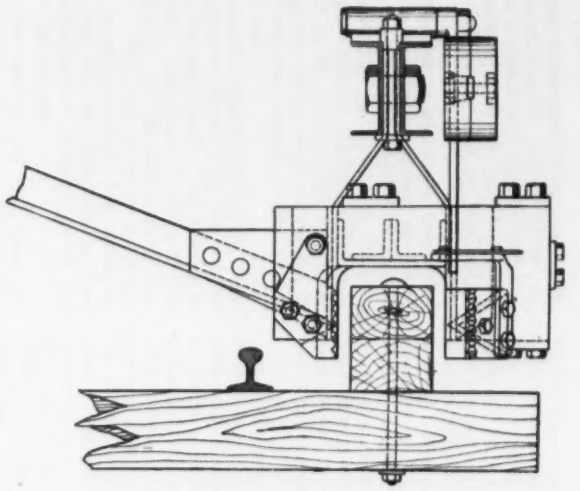

Cross Section.

Sectional Side Elevation.

## DETAILS OF CAR.

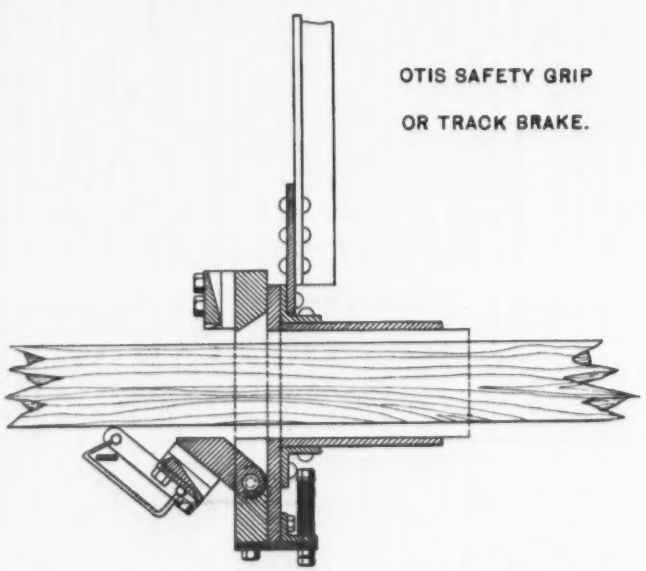



Side Elevation.



End Elevation.

GENERAL VIEW OF INCLINE FROM THE LAKE.



OTIS SAFETY GRIP OR TRACK BRAKE.

Horizontal Section through Jaws of Brake.

VIEW OF TURNOUT ON THE INCLINE.

PROSPECT MOUNTAIN CABLE INCLINE; LAKE GEORGE, N. Y.

Built for the Horicon Improvement Co. by the Otis Engineering & Construction Co. Thos. E. Brown, Jr., M. Am. Soc. C. E., Chief Engineer.

small, at flood stage, knows that it then flows much more swiftly than at ordinary stages. Hence we can be certain that a considerably smaller reduction in the depth of the river than that above indicated will result from a reduction of 4 per cent. in its discharge.

We have used figures in the above illustration merely to indicate the simple method by which any one, with no knowledge of engineering, can determine for himself the fact that the Chicago Drainage Canal, great as is its absolute outflow, will yet have an effect on the levels of the four lower lakes and their outlets which will be measured in inches only, and will not exceed, as the utmost maximum, 6 or 7 ins.

So much for common-sense and arithmetic. Now, what can engineering methods do in the way of a more accurate determination? The answer to this question is that with proper facilities a very accurate determination of the effect upon lake levels is possible. What is necessary is simply to measure the discharge of each lake outlet at various stages, and find the difference in level to which a variation in flow of 10,000 cu. ft. per sec. corresponds at each stage.

Thus far, however, this has not been done, and with the imperfect data at hand, engineers have estimated the effect of the canal upon the lake levels all the way from 2½ to 8 ins. Mr Cooley, in his argument in this issue, assumes the diminution of level which will be produced at 4 ins. The Board of Government Engineers, in its report, refrains from committing itself on this point, merely saying: "Will the loss be 3 ins. or will it be 6 ins.?" and concludes in substance that further gagings of the St. Clair and Niagara rivers are needed to settle this question.

When such high authority hesitates to commit itself, we shall certainly not venture to set closer limits for the fall in levels which will result from the outflow at Chicago.

But the question as to the effect of any given reduction in lake levels upon navigation interests is one that needs no river gagings to settle. It ought to be possible to reach an agreement upon it. Our readers will note a marked divergence on this point between the views of Mr. Cooley and those of the Government engineers. The former gentleman urges, first, that other changes in lake levels are being produced by the dredging of connecting channels without serious objection being raised; second, that a 4-in. reduction in levels will be so small that it would never be noticed as a practical factor in loading vessels; third, that as the shallow channels are to be deepened anyway to 20 ft. or more, they might as well be deepened the trifling additional amount necessary to offset the effect of the Drainage Canal; fourth, that the levels of all the Great Lakes might be raised enough to much more than compensate for the effect of the Chicago canal, by building controlling works at their outlets.

The Government Board, on the other hand, claims that the master of a vessel carries, as a rule, all she can take and get out of the port, or into the port for which she is bound, and hence that a reduction of 3 ins. or 6 ins. means in effect a reduction in the carrying capacity of the bulk of the lake fleet to the extent represented by 3 ins. or 6 ins., less depth of loading.

It ought to be possible to reach a closer agreement on this question. We may grant all that Mr. Cooley says respecting the difficulty of detecting an actual change in lake levels, and as to the means by which a reduction in such levels may be remedied, but it does not seem quite true that the ruling principle of vessel-navigation is, as he says, to "go safe." On the contrary, our information is that the general rule is to load vessels to the water line, provided the channels and harbors to be traversed will warrant it. Whether they will warrant it or not is determined by the experience of vessels in going aground in the various harbors or channels, rather than by assuming an arbitrary margin of safety between the vessel's draft and the published lake soundings, and fixing by that the depth of lading.

Mr. Cooley has well pointed out in his paper that the deepening of the channels to 20 and 21 ft., now in progress, will give existing lake vessels all the water they can utilize, even with the greatest supposable reduction due to the Chicago canal. We do not find, however, that he has taken into account the shallow harbors of the lower lakes, and the fact that with the new deep channels these harbors will fix the depth to which a vessel may be loaded. Apparently he looks forward to a deepening of the lake harbors to correspond to the deeper channels, but, as Mr. Wisner points out in his paper, published elsewhere in this issue, the deepening of these harbors to the greater depths proposed is bound to be a matter of great difficulty and expense.

On the other hand, the published estimates of loss to the lake shipping interests by a 4 or 6-in. reduction in lake levels seem to us considerably exaggerated. If a careful examination were made, it would probably be found that, taking into consideration the vessels of moderate draft and the trips made by the larger vessels with partial cargoes, a large percentage of the traffic would not be affected at all by the slight reduction in levels which is proposed. Again, it is not an absolutely universal rule that cost of carriage decreases with increase of depth. If we remember correctly, the whaleback, which has proved so great a success in the grain and ore trade on the lakes, draws considerably less water than some of the vessels with which it has been in successful competition.

It seems sensible, on the whole, therefore, to conclude that while the reduction in lake levels due to the Chicago canal will have some effect on lake shipping interests, the effect will be very far from the wholesale destruction which has been pictured. Annual changes in lake levels due to natural causes are several times as great as any which the Drainage Canal can cause.

The part of Mr. Cooley's paper which seems to us of greatest interest and attention is his review of the methods by which it is feasible to control the level of all the lakes, and not only entirely remedy any lowering due to the Chicago canal, but to a large extent wipe out the present variation due to natural causes and hold the levels permanently at a point which will in effect add 2 ft. or more to the depths of every harbor and channel on the lakes.

We publish also in this issue a paper by Mr. Geo. Y. Wisner, M. Am. Soc. C. E., in which this project is discussed in much more detail, and it is entirely safe to say that its importance to lake navigation interests is many times as great as that of the Drainage Canal effects. If the agitation aroused by the Drainage Canal work should finally result in works to control the level of the lakes and reduce their variations, the lake shipping interests would have good reason to bestow blessings instead of curses on Chicago and its work.

We alluded at the outset to the interesting legal questions which the Drainage Canal work has raised. The contention of the Board of Engineers that the United States has sole jurisdiction over it is doubtless correct, according to the latest Acts of Congress and court decisions. Would, then, the United States have a legal right to take charge of the canal on its completion, and wholly prevent its use for the purpose for which it was made? We hardly think that the law would justify so extreme a measure.

The general rule governing riparian rights is that any owner has the right to make such use as he pleases of the waters adjacent to his property, provided such use does not interfere with the rights of other owners or with navigation. Chicago has for years been taking from Lake Michigan nearly 1,000 cu. ft. of water per sec. and sending it over the divide to the Mississippi watershed via the Illinois & Mississippi Canal. She is now digging a new channel through which several times this amount will flow. Has she not the right to increase this flow up to the point where some deleterious effect upon lake levels becomes discernible. If all of Mr. Cooley's contentions are correct, a flow equal to the ultimate capacity of the canal will not produce an effect sufficient to enable the shipping interests to prove that an injury has been sustained. It is to be borne in mind, moreover, that a flow of only 5,000 cu. ft. per sec., instead of 10,000, is all that will be drawn from the lake when the canal is opened, and it seems pretty certain that this, at least, can be taken by Chicago without doing appreciable harm to any vested interest.

We may conclude, therefore, that even if the courts compel Chicago to turn over its canal on completion to the Government engineers, they can by no means prevent its use for the purpose for which it was designed. It would be a calamity, indeed, if, after expending $30,000,000 on this great work, the city were not allowed to make use of it; and no such outcome, we believe, need be feared.

The fact has been mentioned that the question at issue is International as well as National. In the above discussion, and in those which we reprint in this issue, the effect of changed lake levels on the depth of the St. Lawrence is not considered, but any satisfactory solution of the problem must certainly provide for the remedy of any injury which may be done to the Canadian canals. Should the reduced flow of the St. Lawrence, consequent upon the flow of the Drainage Canal, cause a reduction of 6-ins. on the depth of water on the miter sills of the St. Lawrence canal locks, Great Britain would have a just claim for reparation, according to international law.

The only satisfactory solution of the whole problem would seem to be for the United States and Canada to at once determine the fensibility of controlling the levels of all the Great Lakes and the waterways which issue from them; and unless unforeseen obstacles are found, to enter upon the execution of the work.

The control of the levels of these great freshwater seas, covering a hundred thousand square miles, would be indeed the most stupendous physical effect ever produced by man's agency, but from present appearances it could be carried out by methods entirely within the precedents of modern engineering, and at a cost quite inconsiderable in comparison with the benefits to be secured.

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An electrical power plant to supply electricity in Salt Lake City is being brought to completion by the Big Cottonwood Power Co., with Mr. R. M. Jones as engineer and manager, and Mr. J. W. Dunelleman as president. The power plant is located on Big Cottonwood Creek, about 14 miles from the city. Here a fall of about 380 ft. will be utilized to drive four 60-in. special double-nozzle Pelton wheels, each with a capacity of 620 HP., net, at a speed of 300 revs. per min. Each wheel will be directly connected with a 450-K-W. three phase General Electric generator. A small storage reservoir, formed by an earth dam, has been built above the power station. A step-up transformer at the power station raises the voltage from 500 to 10,000 and a second transformer at the city reduces it to 2,000 volts. At present the principal customer will be the Salt Lake & Ogden Gas & Electric Light Co., in Salt Lake City. This company has a five-year contract, from Jan. 1, 1896, for all the current it can use for lighting, and in units up to 10 HP. for power, with the exception that more than 10-HP. units may be supplied for running elevators. The General Electric Co., of New York city, has the contract for all the electrical plant except the wire, which is being furnished by John A. Roebling's Son Co., of Trenton, N. J. The steel pipe is being furnished by Fraser & Chalmers, of Chicago. It is used for the supply pipe to the wheels, is 48 and 56 ins. in diameter, and about 3,700 ft. long. The estimated cost of the whole plant is about $300,000. We are indebted to Mr. W. P. Hardesty, C. E., of Salt Lake City, for the above information.

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The traffic through the Baltic-North Sea Canal, in August, amounted to 718 vessels of all classes. The Chambers of Commerce of Kiel and Stettin complain of the new rate of toll going into effect on Oct. 1, which increases the present rate 25%. The system of lighting the canal by electricity is said to be very defective, and during the long winter nights vessels will probably find it inadvisable to attempt navigation at all.

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The Kra ship canal, through the peninsula of lower Siam, was surveyed in 1888, and the right to construct and operate this canal was granted to a French syndicate by the King of Siam; but nothing further has been done. The preliminary surveys call for a canal 22 miles long through a comparatively level country; but details are wanting as to the depth of cutting. The construction of this ship canal would obviate the long and dangerous passage through the Straits of Malacca and save about 1,500 miles of ocean travel; but it would leave far to the south the English port of Singapore, with its present trade of $26,000,000 per annum, chiefly derived from its position as a compulsory port of call for coal and supplies. Hence, probably, the delay in pushing this ship canal, which would chiefly benefit France.

The Lake St. Clair-Lake Erie Ship Canal project has been revived, and a private corporation has secured from the Dominion Parliament a franchise for cutting and operating the canal through the county of Essex, Ontario. The canal proper would be only 13 miles long, and the estimated cost of a canal 21 ft. deep, 100 ft. wide on the bottom and 160 ft. at the water surface, is $4,500,000, not including land damages. The difference in the levels of the lakes is 4 ft., and no locks are proposed. The saving in distance between Lakes Huron and Erie, over the present route, would be about 80 miles.

The ship canal from Bruges to Heyst, on the North Sea, has been authorized by the Belgian Chamber of Representatives to the extent of voting credits for construction. So says a Brussels news item, but no amount of credit or further detail is given.

Progress on the harbor improvement at Aransas Pass, Tex., is described as follows in a letter to this journal from Messrs. Chas. Clarke & Co., of Galveston, the contractors for the work, dated at Ropesville, Tex., Sept. 20, 1895:

It is proposed to build a rock jetty having a brush foundation 1 ft. thick, commencing in a depth of 20 ft. of water outside of Aransas Pass bar and extending shoreward to a point on St. Joseph's Island, a distance of 6,200 ft., and at a cost of about $300,000. It is intended that this jetty shall be completed about May 1, 1896, and that its building will assure at least a depth of 20 ft. of water across the bar. Our present contract, however, is only for the first half of the above work, and will be completed about Dec. 1, this year. We understand from good authority that as soon as the work of deepening the bar has progressed sufficiently to justify an assurance of success, Messrs. Alex. Brown & Son, of Baltimore, who are furnishing the money for the enterprise, will commence constructing docks and warehouses and other necessary facilities for making a permanent deep-water shipping port at this place. Up to this date we have constructed 1,600 ft. of the foundation of the jetty, and the result has been very flattering to the enterprise, as the channel has deepened several feet along the whole line of the new work.

The North River Bridge Co., chartered by Act of Congress of July 11, 1890, had been sued in the New Jersey courts as a nuisance for using steam pumps, engines and drills in constructing an anchorage foundation in Hoboken, and an injunction was sought to be obtained against its continuance. The decision just rendered by Vice-Chancellor Emery, of the Chancery Court in Newark, is regarded as important in connection with the future of this company. The Vice-Chancellor sustains the company's contention that the bridge company is a federal corporation, and that no legislation to give it powers is required from the states of New York and New Jersey. Section 4 of the Act of Congress authorizing the bridge provides that in case of any litigation arising out of the construction or use of such bridge, or approaches and railway thereon, or for the condemnation or appropriation of property, the case so arising shall be tried before the Circuit Court of the United States for the Judicial District in which the bridge or its approaches are located. Vice-Chancellor Emery says the jurisdiction of the Circuit Court of the United States is exclusive, and the general principles controlling this case are well established by decisions of the U. S. Supreme Court. These principles are: (1) That the federal government, under the power to regulate commerce among the states, may create a corporation for the purpose above mentioned (Luxton v. North River Bridge Co., 153 U. S., 525, 1893), and may give the corporation the rights deemed necessary for the purpose. (2) That where rights arise under such law of the United States, Congress may, if it sees fit, give to the federal courts exclusive jurisdiction; and (3) That the state courts can exercise original jurisdiction concurrent with the federal courts in cases arising under such laws of the United States where such concurrent jurisdiction is not excluded by express provision of the Act of Congress, or by necessary implication arising from incompatibility of the exercise of the jurisdiction by the state court in the particular case.

City ownership of all water meters is recommended by the water board of Lowell, Mass. The purchase of some 3,000 meters now owned by private consumers has recently been under consideration by a joint committee of the water board and city council. The estimated cost is given as $40,000. The water board desires to extend the meter system, with city ownership, and if this is to be done the proposed purchase is deemed necessary in justice to those who have already paid for meters. A strong local argument in favor of the meter system is the fact that the new driven well supply is sufficient for only a part of the city, but could be delivered to all if the consumption was reduced to a reasonable figure. Since the driven well supply partially supplanted that from the Merrimac River, it is said that deaths from typhoid fever have fallen off to a notable extent. As the distribution system is arranged it is alleged that two wards of the city are getting the bulk of the river water.

An exhibition of road materials will be made at the Cotton States & International Exhibition, at Atlanta, Ga., and in order to occupy the space allowed to the best advantage, it has been decided to receive small samples by mail, instead of larger ones by freight, and all specimens which can be sent in time for the opening of the "Road Parliament" on Oct. 17 will be received and arranged for exhibition by states and counties. After the close of the exhibition these specimens will be transferred to Washington for permanent use. Further particulars, with franks and directions for free mailing, can be obtained on application to Gen. Roy Stone, Engineer and Special Agent of the Office of Road Inquiry, Department of Agriculture, Washington, D. C.

The new Brooklyn bridge terminal, on the Brooklyn side, was opened to traffic on Sept. 29. The arrangement of this terminal was fully illustrated and described in our issue of July 4.

The contracts for the three new torpedo boats have been formally awarded. The Herreshoffs get two of them at $140,000 each, and the third is to be built by Moran Brothers., of Seattle, Wash., for $160,000.

The franchise offered to the Niagara Falls Power Co. by the Buffalo City Council has been rejected by the company. At present the respective positions of the two parties to the negotiation may be summarized as follows:

Size of Conduits.—Company is willing to erect poles and lay conduits for its own use, for the free use of the city and for one other company requiring as much space as the Niagara company. City insists on conduits with capacity sufficient for two other companies with requirements equal to those of the Niagara company.

Overhead Wires.—Company is willing to remove them on one year's notice. City wants the right to order removal "within such reasonable time as the Board of Public Works and Common Council may require."

Percentage of Gross Receipts.—Company is willing to pay 5% after five years, or 5% on all power above 10,000 HP. delivered. City wants 5% from the acceptance of the franchise.

Term of Franchise.—Company wants a 36-year term. The city offers a 25-year term.

Right to Revoke.—Company objects to a clause giving the Board of Public Works the right to revoke the franchise on ten days' notice for failure to comply with its provisions.

The United States & Hayti Cable Co. is to lay a direct cable from New York to Hayti, and preparations are being made to lay the first section of the cable. The incorporators are John W. Mackay, George G. Ward, J. W. Mackay, Jr., A. B. Chandler, and Albert Beck, all Americans.

The physical condition of the Atchison, Topeka & Santa Fe R. R. is reported by Mr. Charles S. Gleed, one of the directors, as being excellent. He has recently made an inspection of 4,000 miles of the road, including the main line from Chicago to San Diego, and states that much work has been done in replacing trestles with solid banks, putting in ballast, and renewing rails and ties. He considers that trains could safely be run at 40 miles per hour from Chicago to San Francisco, 2,577 miles.

## LETTERS TO THE EDITOR.

### ACCELERATING THE SPEED OF EXPRESS TRAINS.

Sir: In regard to the article on "Accelerating the Speed of Express Trains," in your issue of Sept. 19, while the speed of trains is an interesting question, there are a great many points that have to be considered coincident with it. In your article, as in our daily papers, the relative weight of trains here and in Great Britain are taken into account, as well as the number of grade crossings and other drawbacks to sustained speed on our lines here. But what I have not seen any one mention is the volume of traffic on the American and British lines, except the incidental mention you make of the Midland Ry., of England, not having taken part in the recent racing excitement, owing to its physical disabilities and enormous coal traffic.

According to Poor's "Manual," the New York Central R. R. earned $17,500 a mile last year, on 2,396 miles, and the Pennsylvania R. R. earned $21,500 a mile, on 2,737 miles. The Lancashire & Yorkshire and Midland lines, according to the Parliamentary returns, earned respectively last year $44,000 and $31,800 per mile. The latter figures, one-third greater than those of the Pennsylvania R. R., give a significance to your remark respecting the Midland line not joining in the race to the North.

The lines forming the West Coast route, from London to the north of Scotland, are the London & Northwestern and the Caledonian railways. The former earned on its aggregate mileage (1,892 miles) last year an average of $30,700 a mile, and the latter an average of $18,800 a mile. Of the lines forming the East Coast route, the Great Northern Ry., on its total of 837 miles, earned an average of $25,000; the Northeastern Ry., on its total of 1,620 miles, earned an average of $23,000; and the North British Ry., on its total of 1,202 miles, earned an average of nearly $14,000 a mile.

Figures like these are not of the character one would like to have in making comparisons between one line and another. One would like to be able to make a closer comparison of the volume of traffic between the actual points traversed. For example, the difference of an average earning of $4,000 per mile of line per annum gives little significance to two points in which the Pennsylvania R. R. is similarly related to the New York Central R. R., as you mention respecting the relation of the Midland Ry. to the other competing British lines—namely, its physical disadvantages and its enormous coal and iron traffic. The earning power of these two lines on their main through systems is not, and cannot be, expressed in any general average.

Again, while the Great Northern Ry., of England, is an immense coal carrier, its line from London to York is not honeycombed with colliery lines, like its connection, the Northeastern Ry., which, from a little north of York to some distance north of Newcastle, passes throught a beehive of coal and mining industries, and has a consequent interlacing of its system at very short intervals. North of Berwick the route over the North British Ry. is through a district largely pastoral and partly manufacturing. As to the West Coast Route, it is difficult to understand how the London & Northwestern Ry. could make such speed without great dislocation of its general traffic, particularly through the Staffordshire and other busy districts; and the same is true of the Caledonian Ry. and its grid-ironed system in the lower ward of Lanarkshire.

I merely mention these as factors that have to receive serious consideration, not only in the sense of safety, but commercially, for the whole ordinary passenger and freight traffic of a road cannot be lightly given a subordinate place that a few express trains may be run at exceptionally high speeds. I do not think the British railway companies can afford to do it, and what is more, if an accident happens, the old cry will be revived of having separate lines for freight and passenger traffic. I doubt whether any of the English or Scotch railway companies are prepared to face such a contingency.

What I would like to know, is the relative cost of running trains at different rates of speed. To put the question perhaps in more intelligible form—say, an engine of a certain weight and construction, with a given number of wheels coupled, and a certain size of driving wheels, carries a train of a given weight at 35 miles an hour, and a consumption, or cost, of so much coal and oil, to find out the difference of consumption, or cost, at 40 miles an hour; at 45 miles an hour; at 50, 55, 60 and 65 miles an hour, respectively. Incident to that, of course, would be the relative cost of maintenance of engines running at such speeds, and their working life. The cost of maintenance of the roadbed and all its appurtenances, would also come into consideration. But I fear that the probability of getting such useful knowledge is very remote.

Yours very faithfully, General Manager.
New York city, Sept. 25, 1895.

(It would, indeed, be interesting and valuable to be able to collect and summarize the information to which our correspondent refers, but it would be almost impossible to get sufficient reliable and comparable figures for this purpose, and without such figures any estimate would be composed of so many assumed figures and averages as to render the results of little practical value. The question involved is an interesting one, well worth attention by any one with the time to devote to the investigation of railway economics.—Ed.)

### THE S P R COLUMN FORMULA.

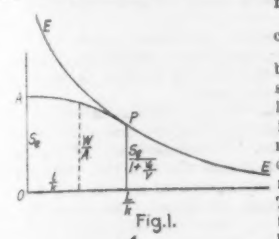
Sir: While I deprecate all unnecessary discussion of engineering formulas, as tending to destroy the confidence of practitioners in their reliability, I cannot allow Professor Du Bois' article on "Formulas for Long Columns," in your issue of Aug. 22, to pass without comment. He claims to give us here "a new rational formula which includes all the others as special cases." He interprets the word rational as meaning that "which contains no empirical constants, and which is the logical result of mathematical discussion based on the accepted theory of flexure." Surely this is an astonishing announcement—that all the various purely empirical formulas for the strength of columns should now be found to be simply special cases of a rational one! The undertaking looks hazardous. Has it been accomplished? Passing by several unfortunate slips of the pen, as where the theoretical values of n in Euler's formula are erroneously applied to the different end conditions, and where the terms convex and concave are interchanged, let us examine the groundwork of this new creation. (For convenience the figures are here repeated.)

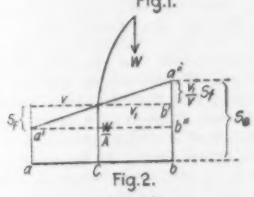
By way of introduction, permit me to remark that Euler's formula for the strength of columns has always been a stumbling block and always will be. Probably it could wisely be omitted from all treatises on the subject. It gives a load which is just sufficient to put a spring in the condition of a bent bow. It

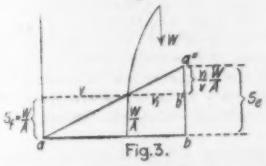
then bends more or less under a constant load. Any diminution of the load allows it to straighten itself, but when its ratio of length to radius of gyration of cross-section is great enough, the stress produced on the outer fibers is supposed to be due only to the cross-bending, in order to have it act in this way. That is to say, the direct stress has to be wholly neglected.

Without following the processes involved in the derivation of Euler's formula, one may see from the formula itself that only the stiffness and not the strength of the column is taken into account. The only function of the material involved is E. Since this is the same for wrought iron as for spring steel, it follows that according to Euler's formula a wrought iron column is as strong as one of hard steel, and that a cast iron column is only half as strong as one of wrought iron of the same cross-section. If the resistance of the column were a resistance to bending only—that is, if the maximum stress on the outer fibers on the concave side were simply that due to the bending, and not partly due to the direct compression, these results would follow. In other words, Euler's formula should never be called a column formula at all, but rather the formula for a bent bow or spring.

1. In the formation of his first equation (a) he makes the serious mistake of making a a', Fig. 2, represent the "direct compression," which is neglected in Euler's formula. The direct compression is $\frac{W}{A}$ = b b', and this is the stress which is neglected by Euler. This is the first fundamental error made in deriving this "new rational formula." The "unit stress due to flexure" is really b' a'', Fig. 2, instead of b'' a'', as stated by our author. This is an error of 100%, since the stress due to flexure is only half as much (for symmetrical sections) as it has here been assumed.




2. The second step in attaining to the "new rational formula" is to assume the length of strut to increase and the load to decrease until the "direct compression" has disappeared, and "true flexure" begins. But since the direct compression is always $\frac{W}{A}$, it evidently can never disappear, so long as there is any load at all on the column, and any assumption that it does disappear leads at once to an irrational result. This is assumed by Euler, and it is the error which makes that formula of no value for practical purposes; that is, so long as the strength of the column as such (and not as an elastic bow or beam) is anything at all. When this strength, or resistance to initial bending under a crushing load, has become practically zero, from the great value of the length as compared to its cross-section, then it ceases to be a structural possibility. In other words, Euler's formula is theoretically (and practically) correct only for impossible struts. Our author's peculiar error here, however, is not in assuming that $\frac{W}{A}$ is zero, as Euler does, but that the compressive stress on the convex side of the strut is zero. In other words, he makes Euler's formula applicable when the tension from bending has just overcome the compression from the imposed load. For if we are to combine these two effects, we must assume a uniformly distributed compressive stress $\frac{W}{A}$, and then a pure cross-bending (uniformly varying) stress, due to the bending of the column. He thus finds a purely arbitrary length of column, beyond which he says Euler's formula applies. Even here he does not attempt to apply it "rationally," since he substitutes for the theoretical end-condition constant n urely empirical values. Thus, instead of using the values of 1, 3-2, and 2, he uses $\sqrt{\frac{5}{3}}$, $\frac{5}{2\sqrt{3}}$, and $\sqrt{\frac{5}{2}}$, thus bringing even Euler's formula well into the empirical class. Further to confuse this matter, our author states that when the length exceeds that above defined, we then have "true flexure, or tension on one side and compression on the other." Since he states above that there is now "no direct compression," he has evidently regarded this "true flexure" as pure cross-bending stress, the same as though it were produced by transverse forces only. Is it possible he thinks so? If so, then for symmetrical sections the tensile stress on one side is equal to the compressive stress on the other. Does he believe this? The reader must infer that he does. That is to say, the load W on top of the column can bend it (and so develop bending stress) without compressing or bearing down upon it at all, for if it did press down upon it, it would develop direct compressive stress over the entire cross-section, which direct compressive stress would, of course, be combined with the bending stress, which is uniformly varying across the section.

3. The distinctive peculiarity, however, of this new formula (aside from the erroneous assumptions) lies in the provision for unsymmetrical sections. This is openly claimed as the great merit of the formula, in the closing paragraph of the article. Now, how can any use ever be made of the values of v and $v_1$, or the distances from the neutral axis to the outer fibers on the two sides? In all these formulas $v_1$ is the distance to the fiber on the concave side of the column, and hence the fiber carrying the maximum stress. But how is one to know which way the column is going to bend? If loaded centrally (and this is assumed in the paper), it is equally probable that it may bend in either direction. We cannot then, in advance, evaluate v and $v_1$, since we do not know which is v and which $v_1$. In all these formulas, therefore, v and $v_1$ must be regarded as interchangeable. But this produces greatly different results. Thus, our author states that "the crippling unit stress $\left(\frac{W}{A}\right)$ is a maximum for $v_1 = 2\ v$." But suppose the column bends the other way, then we have $v_1 = \frac{1}{2}\ v$. What about the strength of the column then? Here again we find that even though v and $v_1$ should retain their significance, and could be evaluated, the statement that the strength of the column is a maximum for $v_1 = 2\ v$ is untrue, since the strength of the column would increase continuously, according to the general equation (preceding (5)) as $\frac{v_1}{v}$ decreases, and there is therefore no true maximum relation. This seems to dispose also of the confirmation of the truth of the new formula found so unexpectedly in the English "long bow"!

4. The next astonishing feature of this "entirely rational" formula "without empirical constants" is that its locus

(a) Is assumed to be a second-degree curve,

(b) Having its axis coinciding with the axis of g, and its vertex at the elastic limit,

(c) And tangent to a purely empirical locus of Euler's formula.

How a locus so assumed can constitute an "entirely rational" location does not appear.

5. Passing now to our author's derivation of all other formulas as "special cases" of his general form

(S) He derives Johnson's straight-line formula by making $v_1 = 2\ v$, although on which sides of an unsymmetrical column $v_1$ and v respectively belong, it would be impossible to say. If, for instance, we had a solid triangular section, and we assume $v_1$ is on the side of the apex and v on the side of the base, then $v_1 = 2\ v$ so long as the column bends towards the apex side, and the straight-line formula "rationally" applies. But if it should bend the other way (which it is equally likely to do), we would have $v_1 = \frac{1}{2}\ v$, in which case the straight-line formula is not at all rationally applicable. That is to say, the rationality of this formula as applied to even such a section depends altogether on the inclination of the column!

(P) by making $v_1 = v$ he obtains my "parabola formula," which makes no pretense of being rational, so far as the parabolic form is concerned. Here, however, the column is assumed to be symmetrical, and hence no interpretation of v and $v_1$ is required. And since it is impossible ever to interpret these when they have different values, this would seem to be the only "special case" to which the new formula is applicable in practice.

(R) By taking the reciprocal with changed signs, of one factor, and also assuming $v_1 = v$, he obtains the Rankine-Gordon formula, admitting, however, that this particular evolution is not a rational derivation. Can it then be called a "special case"?

(M) By the same evolution as the above, with an additional arbitrary omission of a factor four, he obtains Merriman's formula as another special case.

Instead of calling the new formula the "S P R" formula, why should it not rather be called the "S P R M" formula, which is perhaps more easily remembered?

In view, however, of the very limited amount of rationality in the "new formula," of the serious fundamental errors in mechanics involved in its derivation, of the impossibility of evaluating its distinctive functions, and of its reducing at last to the accepted forms only by dropping its distinctive characteristics, and by other and irrational manipulations, may we not well question the advisability of adding it to the already vast and confused mass of literature on this subject?

J. B. Johnson.

Washington University, St. Louis, Mo., Aug. 28, 1895.

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Sir: In his article entitled "Formulas for Long Columns," in your issue of Aug. 22, Prof. A. J. Du Bois claims that Euler's formula is based on the strut being subjected to flexure only, ignoring the effect of direct compression.

Professor Merriman, in his article in Engineering News of July 19, 1894, makes a similar claim.

Are they justified in making this claim? If they are not, then the formulas which they have built thereon are without foundation.

I believe that they are not, but hold instead that Euler's formula gives the greatest direct compression to which an ideal column can be subjected without producing any strain in the column due to flexure; that is, it marks the dividing line between loads which will produce in a column direct compression only and those which will produce flexure in addition to direct compression. Further, I hold that it indicates that a load which will start bending will cause the bending to continue until the strain due to direct compression, together with that due to flexure, will exceed the elastic limit.

In support of this position, I quote the following authorities:

Professor Rankine, on page 351 of "Applied Mechcanics," states:

There is one important proposition, however, which it is here necessary to prove, and that is the following:
Theorem.—That a spring of a given length and section, to the ends of whose neutral surface a pair of forces are applied, will not be bent if those forces are less than a certain finite magnitude.

Then follows a demonstration concluding "and $P = \frac{\pi^2 E I}{l^2}$ and this finite quantity is the smallest force which will bend the given spring in the manner proposed." The expression $P = \frac{\pi^2 E I}{l^2}$ will be readily recognized as Euler's formula.

Thomas Claxton Fidler, M. Inst. C. E., in his paper on "Practical Strength of Columns and of Braced Struts," published by the Institution of Civil Engineers, London, 1886, states:




Fig.1.

When a column with rounded ends is bent to a moderate deflection, under the action of a vertical load, P, as shown in Fig. 1, the conditions which govern the equilibrium of the opposed forces may be found by the ordinary laws of elastic deflection, and thus the value of the equilibrated load, P, may be determined. The action of the load might, in fact, be replaced by the tension of a string, A C, and the load, P, can be neither more nor less than the resilient force (R) of the bow, acting in the line A C.

He then develops the expressions $R = E I . \frac{\pi^2}{l^2}$ and $\rho = \frac{R}{\text{area}} = \pi^2 E \frac{r^2}{l^2}$ and states:

These expressions are in accordance with Euler's theory; and the following propositions may be deduced in regard to the behavior of the ideal column:

(1) Using P to denote any arbitrary load, it will follow that so long as the load P is less than R, there will be no deflection of the column whatever; and if such a deflection is forcibly produced by applying a lateral pressure at the center, the bow will always straighten itself again as soon as the pressure is removed, and will lift the incumbent load by reason of the excess of R over P.

(2) If the load is now increased until it is exactly equal to R, the behavior of the column will be different; the load itself will not produce any deflection, but the smallest conceivable force applied laterally at the center will be sufficient to bend it to any required extent; and if the column is so bent and the lateral pressure removed, it will not now recover itself as heretofore, neither will it yield any further, but it will remain supporting the load in any bent position in which it may be placed. In fact, the column will be in a condition of indifferent equilibrium and will carry the load just as well in one position as in another.

I would also refer to Prof. J. B. Johnson's "Modern Framed Structures," and Professor Church's "Mechanics," in both of which works it is clearly set forth that Euler's formula indicates the dividing line between ideal columns, which are subjected to strains from flexure, and those which are subjected to direct compression only.

If in Euler's formula, "C" be substituted for "$\pi^2$," the formula can be demonstrated in a manner which clearly indicates its significance and is quite simple.

Let C = a factor dependent for its value on the position and direction of the forces.
E = modulus of elasticity,
A = area of cross-section,
l = length of the column,
r = the radius of gyration,
I = the moment of inertia.

d = the deflection of the column,
M = bending moment, which will produce a deflection "d,"
pA = the load which will maintain in equilibrium a column, deflected an amount "d,"
p'A = any load.

The general equation for deflection of beams with constant cross-section is

$$d = \frac{M\,l^2}{C\,E\,I} \qquad (1)$$

hence

$$M = \frac{C\,E\,I\,d}{l^2} \qquad (2)$$

or

$$M = \frac{C\,E\,A\,d}{\left(\frac{l}{r}\right)^2} \qquad (3)$$

$$M \text{ also} = p\,A\,d \qquad (4)$$

$$p\,A\,d = \frac{C\,E\,A\,d}{\left(\frac{l}{r}\right)^2} \qquad (5)$$

$$p = \frac{C\,E}{\left(\frac{l}{r}\right)^2} \qquad (6)$$

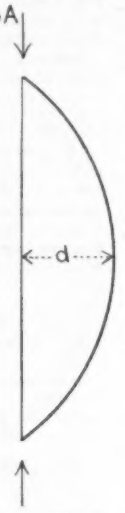


Fig. 2.

Suppose the load p' A substituted for p A. If p' is less than p, the deflection will grow less till it disappears and the column will be simply in direct compression.

If, on the other hand, p' is greater than p, the deflection will increase, until the strain exceeds the elastic limit.

Hence the conclusions: 1st. Any load less than $A\,\frac{C\,E}{\left(\frac{l}{r}\right)^2}$ will produce simply direct compression; 2d. Any load greater than $A\,\frac{C\,E}{\left(\frac{l}{r}\right)^2}$ will cause the column to deflect until the combined direct compression and strain due to flexure exceed the elastic limit.

When the elastic limit is exceeded the further action of the column is foreign to a discussion of Euler's formula.

The foregoing conclusion is a logical deduction from the "Theory of Flexure," which theory is based on certain assumptions which are not quite accurate, except when the deflection is infinitesimal, but which are without sensible error for the deflections which occur in practice. (See "The Strains in Framed Structures," by Prof. A. J. Du Bois, p. 221.) The conclusion reached applies only to ideal columns and not to the imperfect ones met with in actual practice.

The standing of Professor Merriman and Professor Du Bois is such as to give them great influence in forming the opinion of engineers. It is to be hoped, therefore, that they will reconsider their claim, that Euler's is simply a flexure formula, which neglects direct compression, and the conclusions they have based thereon.

Respectfully,
Henry S. Prichard.

Trenton, N. J., Aug. 24, 1895.

Sir: In examining the reasonings advanced by Professor Du Bois in his proposed "New Formula for Long Columns," published in your issue of Aug. 22, one thing will probably strike most engineers—i. e., is there any need for or value in it? He gives a minimum limiting value for the use of Euler's formula as being

$$\sqrt{\frac{v}{Se}}$$

If we take $n = \sqrt{\frac{5}{2}}$, E = 28,000,000 lbs., Se = 30,000 lbs., and put $v = v_1$, we get $\frac{l}{k} = 215$ (approximately), which is such a high value as to exclude Euler's formula from ordinary designing. Therefore, we may assume that Professor Du Bois' formula is to be adopted practically always. Now, certainly, in ordinary cases, the ratio between $v_1$ and v would lie between 1 and 2, and, as he states himself, it is ordinarily 1. If $v = v_1$, then his formula and Prof. Merriman's are both practically the same as the old stand-by of Rankine and Gordon. If $v_1 = 2\,v$, then his formula becomes the "straight line" formula, anywhere between the two. His formula (5) would make hard figuring, to say the least.

No one can object to the logical way which Professor Du Bois has obtained his results, but it would seem as though either Rankine's, or the "straight line," formula answered every needed purpose, covering the ground in the same general way—i. e., by using the ratio of $\frac{l}{k}$ or $\left(\frac{l}{r}\right)^2$ and determining constants by experiments. Engineers and students are already pretty well loaded down with column formulas, and unless some positive gain is proved, we should be slow to add another to the already large list.

Yours sincerely,
Cecil B. Smith.

McGill College, Montreal, P. Q., Sept. 7, 1895.

(We submitted proofs of the above letters to Prof. Du Bois, and append his reply as follows.—Ed.)—

Sir: My article in your issue of Aug. 22 opened with the following two sentences:

A number of rational formulas for long struts have been proposed, and several are in common use. The object of the present paper is to present a new rational formula, which includes all the others as special cases.

It is at once seen that the words "the others" in the second sentence refer to those rational formulas mentioned in the first. Professor Johnson quotes the last twelve words of the second sentence, and then, by his comments, makes me responsible for the astonishing announcement that "all the various purely empirical formulas" are now found to be simply special cases of a rational one. It is perfectly evident that I have made no such absurd statement. That the Professor should say that I did is the really "astonishing announcement," and certainly indicates great carelessness.

He then goes on to make the following criticisms:

1. I commit, he says, the serious mistake of making a a', Fig. 2, represent the "direct compression," which is neglected in Euler's formula, whereas this direct compression is $\frac{W}{A} = b\,b'$. The unit stress due to flexure, he says, is really b' a'', Fig. 2, instead of b'' a''. This is again the result of careless reading and equally unjustified by the text. For "direct compression" should be read "uniform direct compression," as will be at once seen by reference to my paper. I am perfectly aware that $\frac{W}{A}$ is the direct compressive unit stress. I have called attention to the fact that $\frac{W}{A}$ is the uniform direct compressive unit stress at every point of the cross-section when there is no flexure, but that when there is flexure the uniform direct compression is no longer $\frac{W}{A}$, but a a'. This is evidently quite true, and this compression is neglected, of course, by Euler's formula. Professor Johnson has simply confounded the "direct compression" with the "uniform direct compression," and makes me responsible for his own mistake. The unit stress due to flexure on the concave side I really do take as b' a'', Fig. 2, just as he says I should. It is, however, evident from Fig. 2 that $S_f$, the unit stress due to flexure on the convex side, is equal to the remainder b'' b' of the direct unit stress on the concave side.

Since then b'' b' = $S_f$, and $S_f$ is flexure stress, I allow myself to speak of b'' a'' = b'' b' + $\frac{v_1}{v} S_f$ as due to flexure. Professor Johnson's objection is clearly a purely verbal one. A little care would have shown him that the error he claims is not really made by me. The equation

$$b''\,a'' = S_f + \frac{v_1}{v} S_f$$

is undoubtedly correct, and unaffected by his purely verbal contention.

2. My next error, he says, is in assuming the length of strut to increase and the load to decrease, until the "direct compression" has disappeared. Again we have the same careless misstatement. For "direct compression" read "uniform direct compression." I assume the length of strut to increase and the load to decrease, so that the maximum unit stress shall be always $S_e$, until the uniform direct compression a a' disappears. So far from assuming $\frac{W}{A}$ to disappear, as Professor Johnson claims, I actually mark it off on Fig. 3, and letter it, and call attention to its continued existence. The reader will see at a glance how entirely erroneous is Professor Johnson's criticism. He will also see that so far from $\frac{W}{A}$ disappearing, I have plainly written $S_f = \frac{W}{A}$. But since $S_f$ is flexure stress, I have here also allowed myself to consider the entire maximum stress b a'' as due to flexure. The error Professor Johnson claims he ... , therefore, is not made by me. His objection ... still the same purely verbal one. The equation

$$\frac{W}{A} + \frac{v_1}{v}\frac{W}{A} = S_e$$

is also corect and unaffected by his purely verbal contention. When uniform direct compression ceases, and the stress distribution is thus controlled by the flexure, I consider that Euler's formula can be applied. For Euler's formula neglects direct compression, and assumes tension on one side and compression on the other. Now, after uniform direct compression ceases in Fig. 3, we have tension on one side and compression on the other. Hence my limiting length. The absurd conclusions which Professor Johnson thinks I must hold, such as that for symmetric sections the tensile and compressive stresses must be equal, etc., etc., are all, therefore, without justification. They might, it would seem, have warned him of some misunderstanding, had he been willing to credit me with a decent familiarity with the most common fundamental principles of mechanics. To such credit I can claim to be fairly well entitled.

His objection to my use of the modified values of the end condition constant n, instead of the theoretic values, as affecting rationality, is very trivial. It is easily met by using the theoretic values.

3. If a column is constrained to bend in a given plane, the values of v and $v_1$ are clearly indicated. If the column is not constrained, it is not, accidental imperfections apart, "equally probable that it may bend in either direction." All formulas recognize that the bending plane passes through the least radius of gyration. Thus a long rectangular section has its plane of bending at right angles to the longest dimension. Professor Johnson would hardly claim it "equally likely" to bend in the plane parallel to its longest dimension. In my formula the same holds. The plane of bending passes through the least radius of gyration, and the direction of bending in that plane is that which gives the least value for $\frac{W}{A}$. There is, thus, no such difficulty as Professor Johnson claims in evaluating v and $v_1$. On the contrary, my formula is the only one which enables one to determine the direction of bending in those cases where v and $v_1$ are not equal.

4 and 5. I have given good reasons in my article to show that the exact form of the true curve is of no practical importance. The assumption of the vertex at the elastic limit and of the point of tangency are both logical. The assumption of $y = S_e + b\,x + c\,x^2$ is, therefore, logically sanctioned, and since the constants are logically determined, and are not empirical, I consider that the formula is rational within my definition of the term. All the "astonishing features" mentioned by Professor Johnson are characteristic of his own parabola formula. I have simply avoided the assumption of a parabola, and find that both his formula and the straight-line formula are included in mine under certain values of v and $v_1$, and that it is unnecessary to assume either form. If he chooses to demur to my definition of the term "rational," that does not alter the fact that my process of deduction is in these "astonishing features" precisely that which he has used himself. If my result is to be added to the "vast and confused mass of literature on this subject," because he don't like the terms I use to describe it, I do not see how his own is to be prevented from keeping mine company, simply because he doesn't call it "rational."

I cannot give more space to Professor Johnson's criticisms, but the preceding is sufficient to show that the "serious fundamental errors in mechanics" are due to careless misconception. Also, that the "impossibility of evaluating its distinctive features" does not exist. As to "reducing at last to accepted forms only by dropping its distinctive characteristics," that is, v and $v_1$, I fail to see how that is an objection. As to other "irrational manipulations," I am unable to find any justification for such language—mathematical or otherwise.

As regards the remarks of Mr. Smith, I would say that if my formula covers a wider range, and takes account of more data than the others, it would seem worth while. The fact that for ordinary designing it reduces to one of the hitherto-accepted formulas is an added advantage.

I have no space to notice Mr. Prichard's remarks, except to point out that in his equation (1) for deflection of beams, transverse bending force only is considered, and I is the constant moment of inertia for neutral axis through center of mass of section. In the case of combined flexure and compression, the neutral axis no longer passes through the center of mass of section, and I is variable. In such a case, equation (1) no longer holds, and I consider its application erroneous.

Yours truly,
A. J. Du Bois.

New Haven, Conn., Sept. 14, 1895.

## NOTES AND QUERIES.

G. M. T. writes that he desires to communicate with the managing officers of some short line of railway, 10 to 50 miles in length, located in the Eastern states, with a view to the equipment of the line with a new system of automatic block and switch signals, in order to demonstrate the merit of the system. A very attractive proposition will be made to any railway officer who will furnish the desired facilities. Communications may be addressed in care of Engineering News.

"Engineer" is informed that anonymous communications cannot be noticed in these columns. The real name of the writer must be signed to the letter, although it need not be published, unless the writer chooses.

## AS SEEN BY AN ENGINEER.

(Editorial Correspondence.)

The Pennsylvania Steel Co.—The works of this company, located at Steelton, Pa., three miles south of Harrisburg, are now running full in every department. The number of men on the pay-roll is over 4,800, which is the largest ever known in the history of the company. These works have had an eventful history. They were built to make Bessemer steel rails in the earliest days of the American steel rail industry. Two five-ton converters were erected, and an additional converting house was built for four more, but so rapid was the improvement in converter practice that the two converters were able to turn out enough steel to utilize the full capacity of the rail mill, and the four additional converters never were built. Many years afterward, however, when the old-style two-converter plant became out of date, the large building was utilized by placing in it three modern seven-ton converters, and when they were finished and put in operation the original converting house was allowed to remain idle. The open-hearth process was also introduced at these works at an early date, two 10-ton furnaces being built, which were afterwards replaced by 20-ton furnaces with removable tops. The original blast furnace plant, with two furnaces, was doubled, and the works for many years did a highly profitable business in steel rails and in blooms and billets, which were sold to other rolling mills. Evil times, however, came upon the steel rail trade. The building of railways and the demand for steel rails fell off, while competing mills were increased in number and capacity, so that the making of rails became a poor dependence for any steel works. The Pennsylvania Steel Co. was, therefore, compelled to keep up with the procession, and large sums of money were invested in building a merchant steel mill, in new open-hearth furnaces, and in general improvements. The company also became involved in the building of the new works of the Maryland Steel Co. at Sparrow's Point, Md. The cash surplus was not sufficient to stand this heavy drain in the face of a falling market, and the company, together with the Maryland company, went into the hands of receivers. Reorganization followed, and both companies are now out of the receivers' hands and are taking advantage of the present advance in prices. Many improvements have recently been made in the plant, and others are in progress. One of them is a splendid group of six open-hearth furnaces of the rotating or oscillating type, each capable of melting 100,000 lbs. of steel in a heat. The whole furnace is enclosed in a sheet steel casing, which rests on a series of rollers rolling in the sector of a circle. The furnace is rolled in one direction, in order to bring the charging door upwards, so that the charge may be dropped in, and in the contrary direction for discharging the melted steel into the ladle.* The casting ladle is carried by a huge electric and hydraulic crane, which traverses the whole length and width of the casting house. Electric power is used for the traversing motions and hydraulic for lifting. A smaller electric crane is also used for charging, the stock being loaded into rectangular sheet steel boxes, which are lifted by the crane above the charging door and the stock poured from them into the furnace. Some of these furnaces are run by the basic process, others by the acid. Their product is chiefly cast into ingots for plate, which are rolled into the shape of flat slabs in a large universal mill, and sold to other mills in this shape. The Bessemer department is undergoing radical alteration, The three seven-ton converters are to be replaced by ten-ton, and the casting pit is to be served by an electric crane. Preparations are being made to bring melted pig metal direct from the four blast furnaces to two iron mixers placed alongside of the converter house, from which, after mixing, it will be lifted in ladles to the mouths of the converters.

A large portion of the Bessemer product is now being rolled into girder rails for electric street railways. The development of the trolley road promises for some time to come to make a more important outlet for the product of these works than the demand for rails for steam railways. The girder rails for city roads are usually 9 ins. high, weighing 85 or 90 lbs. per yard. For country roads they are generally lighter. In connection with the manufacture of girder rails the switch and signal department of the works has a large business in the making of curves, turnouts, frogs and switches for electric railway work. Steel castings also form a considerable part of the output of these works, three small rotating open-hearth furnaces being kept busy in this department.

On the whole, the works at present show abundant evidence of prosperity and of progress. When the improvements now being made are finished, the works will be thoroughly modernized and able to hold their own in the competitive struggle which all manufacturers of steel have nowadays to maintain.

The Harrisburg Foundry & Machine Co.—The works of this company were formerly known as the Foundry and Machine Department of the Harrisburg Car Works, but are now owned by an independent corporation. They comprise a well-equipped foundry, engine and machine shop and boiler works. They have been noted for some years as the builders of the Ide and the Ideal steam engines, both of which are of the high-speed shaft-governor horizontal type, the former being a side crank engine and the latter a center crank, especially adapted to electric railway and similar heavy work. A peculiar feature of the governor of these engines is that the positions of the pivots of the swing arms are adjustable in a radial direction, the adjustment giving a most convenient means of regulating the sensitiveness of the governor. The Ideal engine has an especially heavy bedplate, and the bearing surfaces are liberally proportioned. The valve in the single-cylinder engine is a piston valve, with a removable bushing containing the ports, and a piston which has two rings covering its entire width, which may be set out by positive adjustment, so as to compensate for wear of the rings and of the bushing.

A tandem compound engine of 700 HP. is now being built in which the high-pressure cylinder has a piston valve and the low pressure a balanced slide valve. The armature of an electric generator will be mounted directly on the engine shaft.

One of the leading specialties of these works is a steam road roller, and several of these are now in the shops. The design of this roller is unusually handsome for such a machine, and the workmanship is excellent.

The Pennsylvania Railroad Shops at Altoona.—Your correspondent had only three hours of daylight to spend in Altoona, entirely too short a time in which to see properly the three extensive shops of the Pennsylvania Railroad Co., but enough to allow of a rapid walk through them all and a stop here and there at various points of interest. The chemical laboratory, presided over by Dr. C. B. Dudley, past whose rigid inspection all material purchased by the railroad is required to go, has outgrown its old quarters at the lower shops, and is now temporarily located at the car shops while alterations and enlargements are made in the old building. The physical testing laboratory is still in the lower shops. Mr. Alfred E. Gibbs, the Engineer of Tests, is now engaged in an investigation of the properties of different varieties of iron for locomotive staybolts. The locomotive repair department in the lower shops as busy, as usual, but the building of new locomotives is progressing rather slowly.

In the car shops nothing especially novel was observed, and they do not appear to be very busy. The excellent arrangement of these shops, and their splendid equipment are all known in railway circles.

The Juniata shops, built by the company about five years ago, are famous for their fine equipment. Their capacity is 150 locomotives a year. The extensive use of hydraulic power in these shops was much criticised when they were first built, but they have given continued satisfaction and furnished an excellent illustration of the fact that in engineering it is often possible to perform work by two methods entirely different, which yet will give about equally good results.

An interesting improvement in the manipulation of the reversing valves of Siemens' regenerative heating furnaces is in use at these shops. The reversing of the direction of the currents of air and gas involves the changing of the position of four valves, which must be done in the proper sequence in order to avoid the danger of explosion. In the improved arrangement each valve is moved by a pneumatic cylinder. The four cylinders are all controlled by one plug valve, rotated slowly by a hand wheel, which opens four ports, one after the other, in the right order, so that the workman cannot vary the order if he tried.

The heating of the great machine shop is done by the blower system of carrying air over a series of coils of pipe placed in a large box, which are heated by exhaust from the engines, and driving it through a system of air pipes leading to all parts of the shop on both of its floors. The heating of the shops has been perfectly accomplished by this means, and only in the very coldest weather has it been found necessary to supplement the exhaust with some live steam. The shops have an unusual proportion of window surface, half of them having an open northern exposure, and they would be difficult to heat by the ordinary radiator system, but by the blower system they are heated perfectly and with the utmost convenience.

An important experiment in compound locomotives is now being undertaken by these shops. Four locomotives of the two-cylinder compound type are now being built with the same dimensions, with cylinders 20 and 29 ins. diameter and 28 ins. stroke, on different systems—viz., those of Von Borries, Goelsdorf, Richmond Locomotive Works and Pittsburg Locomotive Works. The difference consists chiefly in the intercepting valve. In addition to these four engines a fifth is being made with simple cylinders. The engines are all of the mogul type for fast freight service. When these are tried, the relative merits of the simple and compound engines of the several forms will be determined, with the view of the adoption of the best as the standard form.

The Cambria Iron Works, Johnstown, Pa.—These works show evidence of the existing revival in the iron trade, all departments being busily engaged. The new rail mill is now running on 9-in. girder rails for street railways. The rails are made from Bessemer ingots, weighing about 6,600 lbs. each, which are rolled into blooms in the old blooming mill, sheared to proper lengths, and conveyed on a power-driven roller conveyor to the new mill, where they are charged by a remarkably efficient charging apparatus into the heating furnace, and when drawn therefrom are rolled in two trains of rolls driven by a Porter-Allen engine of 3,000 HP., and finished at the same heat in a third train driven by another engine. The whole process of making these rails, from the ingot to the finished rail, is a fine sample of steel works engineering, in which practically all the operations are done by machinery, the manual labor consisting chiefly of moving the levers controlling the several valves.

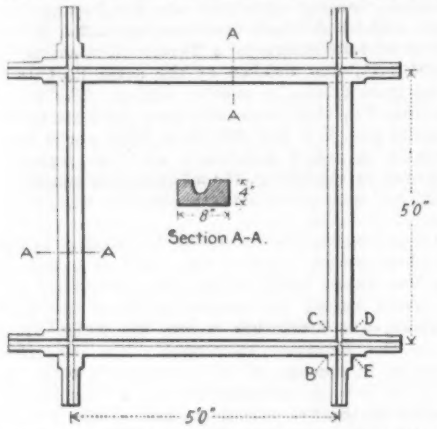
Improvements are constantly in progress in the Cambria works. One of the latest is a 300-ton pig iron mixer, which receives the melted pig iron in ladles hauled by locomotives from the blast furnace, and discharges it into the ladles which serve the Bessemer converters. The converters are four in number, of 12 tons capacity each. In order to increase their capacity a new blast engine, similar to the two already in use, is about to be erected. The open-hearth department now contains three furnaces, one of them a Pernot revolving furnace. There were formerly two Pernots, but one has been changed to a stationary furnace. There is also connected with the open-hearth plant another revolving furnace used as a dephosphorizer on the Krupp method. Melted pig iron is run into it from cupolas, and it is washed with lime and iron oxides, which remove the phosphorus in the slag. The product is a white pig containing only .01% phosphorus, which is used chiefly for making special steels, such as spring steel, which are utilized in the Gautier steel department, which takes a large part of the product of the Cambria works and puts it into finished marketable shapes.

One of the most important enterprises recently undertaken by the Cambria Co. is the erection of

* Described and illustrated in Engineering News Sept. 15, 1892.

a new plant for making coke, on the German system, utilizing the gaseous by-products. This system has been proved an immense success in Europe. The Cambria plant is the first to be attempted in this country, but it will be some months before it will be put in operation.

The Johnson Co.'s Switch Works, Moxham, Pa.—The Johnson Co. built a works several years ago at Moxham, three miles from Johnstown, for the manufacture of street rails. The development of cable and electric traction on street railways gave the company a highly profitable and rapidly-growing business, and the manufacture of switches, frogs, curves and crossings became a large industry in itself. Recently the company has erected a large Bessemer plant at Lorain, O., and has moved there its rail-rolling mills, but the switch department remains at Moxham, forming in itself a works of vast dimensions. One of the imposing features of the works is a great floor or yard, paved with brick, about 200 ft. wide and perhaps 600 ft. long, on which are erected the curves, junctions, turnouts, crossings, etc., before shipment. This floor is served by a traveling crane, consisting of a bridge spanning the whole width of the yard and traversing its whole length, the engine being under the support at one end of bridge, and running on a railroad track, the other bridge support being carried on two wheels running on a single rail.

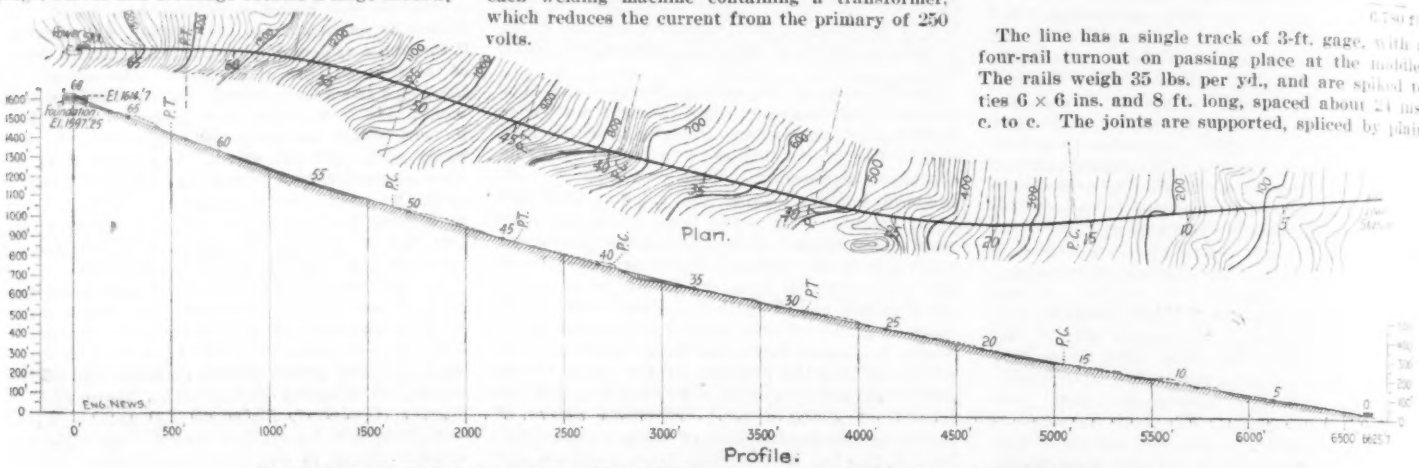



A Street Railway Crossing Constructed by Electric Welding.

Motion is conveyed to these two wheels from the engine at the other end of the bridge by a rotating shaft on the bridge itself, and a heavy link belt connection from a wheel on this shaft to sprocket wheels on the axles of each of the wheels carrying the support.

The most novel feature of these works is the extensive use made of electric welding. It is applied not only to the butt welding of rails into a continuous track, which has now been adopted in Johnstown, Brooklyn and Detroit, but to the manufacture of frog plates, crossings, etc. The making of a crossing plate in a single piece involves one of the heaviest examples of electric welding that has yet been attempted. The crossing is made of rolled steel bars, of a cross-section of about 8 × 4 ins., formed as shown in the accompanying sketch, the eight dotted lines at the corners showing the location of the welds. The grooves are cut, and the eight ends of the crossings milled to the form of the rails with which they are to be connected after the welding is completed. One corner is welded at a time by means of a massive apparatus comprising four welding machines, which weld simultaneously the portions marked E, B, C, D in the sketch, the line E, B when completed forming one continuous weld. The welding is all done by the incandescent system, with a low-tension current of about seven volts, each welding machine containing a transformer, which reduces the current from the primary of 250 volts.

For occasional patching, such as the building up of low spots or filling of cavities, the arc system of welding is used. This is merely the application of a carbon point to the point to be heated, and the formation of an arc, which in a few seconds fuses the patch and runs it into the cavity.




PLAN AND PROFILE OF PROSPECT MOUNTAIN CABLE INCLINE, (LAKE GEORGE, N. Y.)

## THE PROSPECT MOUNTAIN CABLE INCLINE RAILWAY; LAKE GEORGE, N. Y.

(With Inset.)

The latest addition to inclined railways built in this country for the attraction and accommodation of tourist traffic is the Prospect Mountain Incline Railway at Lake George, which was built last winter for the Horicon Improvement Co. The railway starts from a point near the terminus of the Delaware & Hudson R. R. at Caldwell, N. Y., and ascends Prospect Mountain, about 1½ miles west of that place, rising in 6,625.7 ft. to an elevation of 1,950 ft. above Lake George and 2,250 ft. above sea level. From the summit of the mountain there is a wide range of view, comprising the southern peaks of the White Mountains in New Hampshire, the Green Mountains in Vermont, the Catskill and Adirondack Mountains in New York, and the Berkshire Hills in Massachusetts. Lake George is the largest and most easterly of the lakes of the Adirondack region. It is about 210 miles from New York and 71 miles from Albany. The lake is 346 ft. above sea level and 247 ft. above Lake Champlain. The region is a famous summer resort, and is rich in historical associations, the ruins of Fort George, Fort William Henry and Fort Ticonderoga serving as reminders of the early days when numerous battles were fought here between the French and English armies and the Indians. The names of Generals Abercrombie, Howe and Burgoyne, of the English armies, and General Montcalm, of the French army, are associated with the military history of the region.

The old Lake House, at the summit of Prospect Mountain, was bought last year by Mr. Wm. M. Peck, of Glens Falls, N. Y., who has made considerable improvements and extensions, and the railway and hotel are owned by the Horicon Improvement Co., of which Mr. Peck is President and Mr. A. B. Colvin, of Albany, N. Y., State Treasurer, is a director. Construction of the railway was commenced on Jan. 2, 1895, and was carried on through many difficulties incident to the cold and snow. The first car was run on June 2 and the road was opened to traffic on June 15. The total cost was about $120,000.

The length of the line, measured on a level, is 6,625.7 ft., and the total rise is 1,594.7 ft., the length measured on the grade of the incline being 6,780 ft. The average grade is 24%, the maximum grade being 37.8% and the minimum [illegible]. The alinement, commencing at the lower station and not including the turnout curves at the middle, is about as follows:

| | |
|---|---|
| Tangent | [illegible] ft. |
| Curve, 4,200 ft. radius, to the right | [illegible] " |
| Tangent | [illegible] " |
| Curve, 6,000 ft. radius, to the right | [illegible] " |
| Tangent | [illegible] " |
| Curve, 3,600 ft. radius, to the left | [illegible] " |
| Tangent | [illegible] " |
| | 6,780 ft. |

The line has a single track of 3-ft. gage, with a four-rail turnout on passing place at the middle. The rails weigh 35 lbs. per yd., and are spiked to ties 6 × 6 ins. and 8 ft. long, spaced about 24 ins. c. to c. The joints are supported, spliced by plain fishplates, and the ends of the rail base are notched for spikes to prevent creeping. On each side of the track is a yellow pine guard rail, 6 × 8 ins., built up of two timbers 6 × 4 ins., laid to break-joints and bolted with mushroom-headed bolts at each tie. These guard timbers are embraced by the Otis double-grip safety brake, which is applied automatically in case of the car getting beyond control, or can be applied by hand in case of emergency. The ties rest upon longitudinal timbers, 6 × 10 ins., which are bolted to mudsills spaced 6 ft. 8 ins. apart, or 4 ft. apart under the joints of the stringers. The line is in cut and fill, with the exception of four trestles. On the lower half of the line the excavation is mainly in earth and hardpan, while on the upper part the excavation is in granite. The four trestles aggregate 1,400 ft. in length, and have a maximum height of about 25 ft. They are built of native hemlock, except that the stringers are of Southern yellow pine, and the construction closely resembles that used on the Catskill Mountain cable incline, shown in our issue of Aug. 18, 1892. The bents are 16 ft. apart, and are built up of two plumb-posts 10 × 10 ins. and two batter-posts 8 × 10 ins., formed into sills 10 × 10 ins., and caps 10 × 10 ins. × 8 ft. The transverse diagonal bracing is of planks, 2½ × 8 ins., spiked to the caps and sills, and longitudinal diagonal bracing is placed between some of the bents. There are also longitudinal timbers, 4 × 8 ins., bolted to the inside of the bottom of the plumb-posts. Under each rail are two stringers 6 × 14 ins. on edge, laid to break-joint, and separated by 2-in. thimbles, and these stringers rest on corbels 6 × 12 ins., 3 ft. long, notched onto the caps, to give the proper inclination for the stringer bearings. The ties are 6 × 6 ins., 18 ins. apart in the clear. They are 13 ft. long, carrying a 42-in. footway on one side, protected by a wooden railing 4 ft. high.

The work was laid out entirely by measurements parallel to the grade line, so that the difference of elevation at any two stations is the sine of the angle of the slope at that point, the horizontal distance being the cosine. The contours on the topographical plan accompanying the profile represent, therefore, not a vertical projection, as in ordinary practice, but a development of the topography by rolling out on the grade line. This method is said to have greatly facilitated the calculations of grade and power required. The grades are so adjusted that the two trains with average

loads, and including the weight of the cable, balance each other at all points of the line. The curvature of the grade is not continuously convex downward, but is flattened for a short distance near the turnout by means of a curve convex upward, making a slight reverse curve in the profile. The calculations for balancing grades were made for cars weighing 14,000 lbs., carrying 27 passengers at 150 lbs. each (or 18,050 lbs. at each end of the cable), and a cable weighing 2½ lbs. per ft.

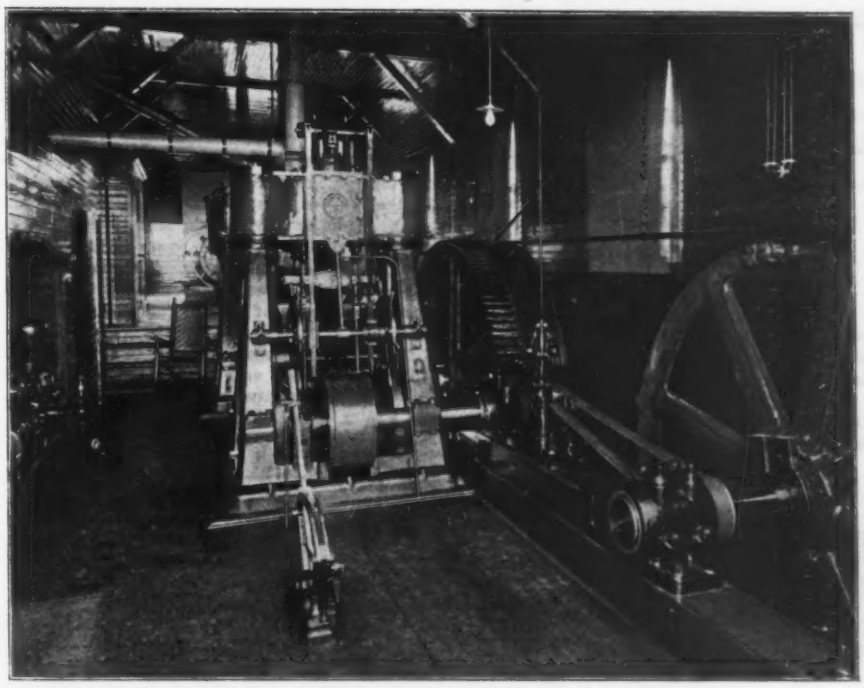
The cable is 1¼ ins. diameter, weighing 2.528 lbs. per ft., and is 7,150 ft. long, making four wraps on the winding drums. The ends of the cable are attached to the downhill side of the car frames, the cable passing under a saddle at the front of the car, which holds it down to within a few inches of the idler pulleys. These pulleys are of cast iron, 12 ins. diameter (to center of cable) on the tangents and 15 ins. on the curves, the latter being inclined towards the center of the curve and having a very high flange on the outer side. The pulleys are set 30 ft. apart, those for the ascending and descending cable being set two tie spaces apart, in order to provide room for the boxes and bearings. The pulley bearings run in babbitted boxes, and these boxes are supported by wrought iron straps bent to shape and fastened to the ties by lag screws. At the turnout the cable, which is normally above the rails, passes through a slot in the rails, dropping into the slot by its own weight and being guided by special pulleys for this purpose. The turnout is operated automatically.

The cars are open, with canvas side curtains for use in bad weather, and have nine transverse seats, the seats being so set as to be horizontal on the grade. Each car is about 32 ft. long and 7 ft. 6 ins. wide, weighs a little over 13,000 lbs., and has seating accommodations for 54 passengers, while 80 or 90 pesons can be accommodated by standing. The front platform is of extra length, and is intended to carry freight and baggage. The car frame is of channel iron, and each car is carried on four 24-in. wheels, the wheelbase being 20 ft. The wheels on one side (on the outer rail) are double-flanged, or grooved, while those on the other side are flat, 8 ins. wide, in order to pass over the turnout, the flat wheel passing over the slot through which the cable drops, as above described. There is telephone communication between the cars and the power house, a copper signal wire being supported on iron standards attached to the ends of the ties, as shown, each car having a wire loop contact piece attached to the end of a vertical rod and held down upon the line wire by a spring. This wire contact replaces a grooved contact wheel, which was found to be liable to jump off the wire. Each car is also fitted with the necessary equipment of batteries, telephone and signal bell, and there is a code of bell signals for starting and stopping. The running speed is 850 ft. per minute, or about 10 miles per hour, and the trip occupies about eight minutes on the average.

The safety grip consists of a heavy steel plate embracing the guard timber and resting against a butting frame of plates and angles, forming part of the car frame. A hinged dog is attached to the grip plate, and lies on the inner side of the guard timber. Both plate and dog have chiseled edges and are fitted with toothed plates. The hinged dog is held away from contact with the guard timber by a weighted lever having a vertical leg, whose end rests in the notch of a latch carried by a shaft, which is fitted with a pawl opposite the speed governor of the car axle. The main grip plate is held away from contact with the guard timber by a brass spring. The governor itself is similar in operation to the ball governor of a steam engine, but the balls are replaced with heavy plates, or jaws, having lugs or teeth formed on the outer edges. When the car attains excessive speed in descending, the plates fly out far enough to bring the teeth in contact with the pawl, thus releasing the latch and causing the weighted lever to drop, forcing the toothed dog and grip into the guard timber to a depth of about ⅝ in. on each side. The resisting power of this safety grip, acting on a yellow pine guard rail, has been found by experiment to be 28,000 lbs. The governor is set to act at a speed of 14 miles per hour. To release the grip, the motion of the car is reversed, so as to relieve the strain on the grip, and the conductor then pulls up the lever and sets it in the latch, after which the car can go ahead again. As the car must be drawn back before the grip can be released, it is evident that the conductor cannot release it unless the cable is intact. If from any cause the car should get beyond control, the conductor can apply the safety grip, throwing the latch by means of the handle shown in front of the dashboard, without waiting for the car to attain sufficient speed to cause the governor to apply the brake.

The hoisting plant is contained in a power house at the upper end of the incline. It consists of two Otis vertical inverted compound engines of the marine type, with cylinders 8 × 10 and 12 × 10 ins., and running at about 200 revolutions per minute. The exhaust of one engine is used in the low-pressure cylinder of the other, and valves are arranged in the steam pipes so that both engines can take live steam direct from the boilers in case of extra heavy loads, but this has not been necessary so far, as the engines are found to be capable of doing all the work required when working as compounds. They develop about 90 HP. when working compound, and can develop up to 200 HP. when working simple. Each engine drives a pinion 23 ins. diameter, the pinions being on opposite sides of the main spur wheel, which has a diameter of 8 ft. on the pitch line, a face 9 ins. wide, and teeth set at a pitch of about 2½ ins. The shaft of this wheel drives two cast iron drums 8 ft. diameter, one being an idler and the other a driving wheel, and the cable makes four turns round these drums. The engines are provided with a hand brake, and also with an emergency brake acting on the main driving drum, but there has been no necessity for the use of either of these brakes as yet, the working being completely controlled by the use of the steam valves. Steam is supplied by a Heine water-tube boiler of 200 HP., built by the Heine Safety Water Tube Boiler Co.,of St. Louis, Mo., and this boiler also supplies steam for the electric plant for lighting the stations and hotels connected with the plant. The current is generated by a Westinghouse alternating dynamo, with a capacity for 1,100 lights of 16 c. p. There are converters at top and bottom of the incline. The water is taken from a mountain brook and pumped up into tanks of 12,000 gallons capacity at the power house by a special boiler and pump placed in the valley to the west of the summit, at a point about 4,000 ft. distant from, and 600 ft. below, the summit. The supply of water is also used for the hotels and other buildings.

The road was designed and built for the Horicon Improvement Co., by the Otis Engineering & Construction Co., of New York city, and the operating plant was designed by Mr. Thomas E. Brown, Jr., M. Am. Soc. C. E., Chief Engineer and Manager of the latter company, to whom we are indebted for drawings and particulars used in preparing this article. Mr. C. F. Parker was the Resident Engineer. The grading trestles and trackwork were sublet to Mairs & Lewis, of New York city. The engines, safety devices, etc., were furnished by Otis Brothers & Co., of New York city, and the winding drums, pulleys, cars and frog and switch equipment by the Ramapo Iron Works, of Hillburn, N. Y. The cable, which is of the Lang-Lay pattern, was made by the John A. Roebling's Sons Co., of Trenton, N. J. The electric lighting plant was furnished by Westinghouse, Church, Kerr & Co., of New York city.



VIEW OF INTERIOR OF POWER HOUSE OF PROSPECT MOUNTAIN CABLE INCLINE.

## THE ELECTRICAL PUMPING PLANT AT DE KALB, ILL.

By Daniel W. Mead, M. Am. Soc. C. E.

A municipal pumping plant which possesses some novel features was recently designed and installed at De Kalb, Ill., under the supervision of the writer.

De Kalb is a city of about 5,000 inhabitants, located 60 miles west of Chicago. It has had a system of water-works since 1879, but the system has not kept pace with the city, and has been gradually losing in efficiency as the demand for water has increased. This had become so marked that the operating expenses during the fiscal year 1893-94 amounted to $1,135 more than the revenue; and this with a consumption of 98,000 gallons per day.

The water was pumped from a deep well by a direct-acting deep-well pump into a stand-pipe 22 ft. in diameter and 80 ft. in height, from which it was distributed to the mains. During the summer months the pump had to be run 24 hours per day, and even then the water had to be shut out of the mains except for short periods at morning, noon and night, in order to keep water in the stand-pipe for fire purposes.

The old plant, which had been worn out, has been abandoned, and a new plant has been erected on lower ground in another part of the city. The new plant is to be run by electrical power, furnished by the De Kalb Electrical Co., under a 10-year contract. The water supply is to be drawn from a deep well, which is 890 ft. in depth, penetrating the St. Peter sandstone, from which much water is

obtained through northern Illinois and southern Wisconsin.

The outcrop of this water-bearing stratum through southern Wisconsin, and also that of Potsdam sandstone, which is another water-bearing stratum, lying below it, is shown on the accompanying geological map, and their relative elevation are shown on the profile, Fig. 1. The waters falling on the exposed outcrops of these deposits in Wisconsin sink into their previous strata, and flow southward, following the dip of the rock. They are reached by the drill at various places, and give rise to flowing or deep wells, according to the relative elevation of the strata and the hydrostatic pressure of the water in the stratum.

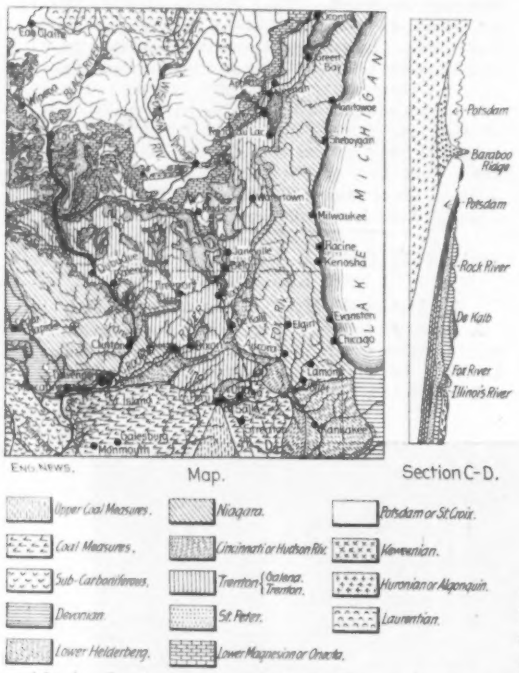
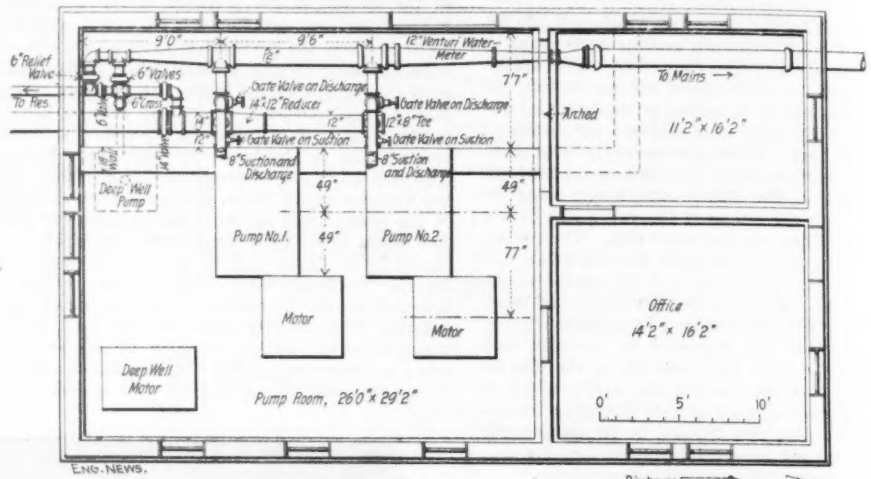



Fig. 1. Geological Map and Profile of Southern Wisconsin and Northern Illinois.

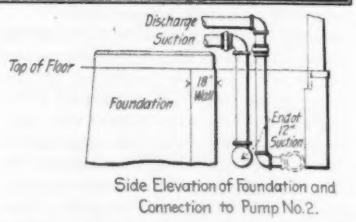
At De Kalb, which, as the profile shows, is on a high ridge, the water rises only to within 65 ft. of the surface. On testing the well at De Kalb to 300 gallons per minute (the desired rate of pumping), the water surface descends to 165 ft. below the surface. From this point, therefore, it has to be raised by a deep-well pump. The pump to be used for this service will be a modified form of the Downie deep-well power pump, which is now being constructed, while a temporary pump is now in use in the well. The deep-well pump is run by a 25-HP. multipolar motor having a speed of 560 revs. per min. at 220 volts, and is connected to the deep-well pump by a 12-in. belt. The deep-well pump raises the water from the well into the reservoir, which is a circular brick structure, having a capacity of 500,000 gallons.

From the reservoir the water is forced into the mains by two vertical single-acting triplex pumps, having plungers 10 ins. in diameter and 12-in. stroke, and a capacity of 500 gallons per minute each, made by the Goulds Manufacturing Co., of Seneca Falls, N. Y. Each pump is run by a 50-HP. multipolar electrical motor. The motors are furnished by the General Electric Co., and show on test an efficiency of 91% at full load, and 84.8% at half load.

The Goulds pumps developed an efficiency of over 75% at full load and 68% at half load. The arrangement of pumps, motors, and piping is shown by Fig. 2, and Fig. 3 is a view of the pumps and motors, reproduced from a photograph. The water pumped is measured both by pump-revolution counters and by a 12-in. Venturi meter. The De Kalb Electrical Co. receives 4 cts. per 1,000 gallons for all water pumped into the mains. The average pressure pumped against by the service pumps is 62½ lbs., and no extra compensation is paid for fire pressure, which must be furnished at any pressure desired by the city, up to 125 lbs. The contract with the De Kalb Electrical Co. requires a minimum depth of 15 ft. of water maintained in the reservoir, and a minimum height of 55 ft. of water in the stand-pipe, both of which are recorded on automatic recording gages in the office of the city clerk. An automatic recording gage is also arranged to keep a record of the variation of the height of water in the deep well at all times.




PLAN OF ELECTRIC PUMPING STATION, DE KALB, ILL.




Side Elevation of Foundation and Connection to Pump No.2.

The motors are operated entirely from the power station by three feed and two return wires, by means of which any or all pumps can be started at one time. The wires are carried from power house to pump house by two separate circuits to avoid possible accident. Accidents to the motors, due to starting the pumps against closed valves, are prevented by fusible plugs, which will burn out if the current becomes too high. The mains are shut off from the stand-pipe in case of fire by a Dousman automatic pressure retaining valve, which closes when the velocity of water into the stand-pipe exceeds 500 gallons per minute (see Eng. News, Jan. 4, 1894). The pressure in case of fire is regulated by a relief valve, which is fixed to discharge into the reservoir when the pressure exceeds the desired amount.

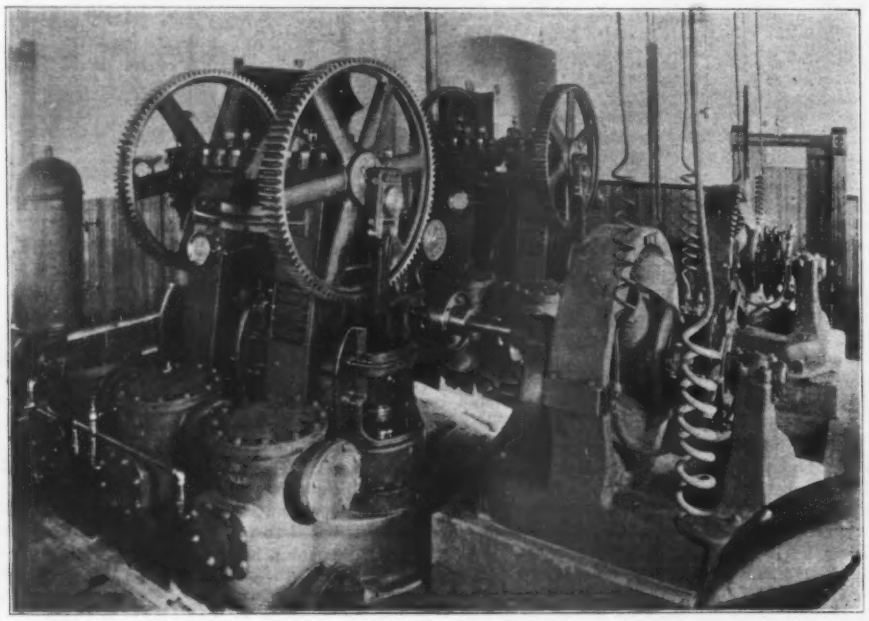


FIG. 3. VIEW OF GOULD'S TRIPLEX ELECTRIC PUMPS IN DE KALB STATION.

Since the above article was put in type, a more extended description of this plant and the circumstances which led to its adoption has appeared in the "Journal of the Association of Engineering Societies." This description was also prepared by Mr. Mead, and was read before the Western Society of Engineers. We extract from it some additional information regarding the electrical pumping plant, and also some facts which forcibly illustrate the bad results and high expenditures which so often follow attempts to construct engineering works without proper advice and to operate them with incompetent men in charge. Those responsible for small engineering works are oftentimes subjected to the greatest temptations to supposed economies in the above manner. Having but little money to expend, they are on the lookout for some cheap expedient, ignorant of experience along the same line elsewhere and unwilling to pay out a portion of their meager funds for the advice of a competent engineer. The results, as is too well known, are often makeshift after makeshift, which in the aggregate cost far more than good advice with the resultant good works at the start, and this for mere construction, while the additional expense and decreased revenue which result from operating badly-designed and constructed plants swell the waste of money still further. Officials entrusted with the execution of municipal works could save their constituents much

money by recognizing the principle that the smaller the sum a village or town has to expend in engineering work, the more necessary it is for it to secure sound engineering advice in deciding how to do the work. The additional information abstracted from the above-mentioned paper is as follows:

The works built by the city in 1879 was the result of circumstances rather than intelligent design, and proved far from satisfactory. Agitation for works began as early as 1872. A 4½-in. well was sunk to a depth of 1,000 ft. with the hope of securing a flow. The water did not rise to the surface, and soon after a pump and windmill were erected. In 1878 it was decided to go deeper, and a second 4½-in. well was sunk, this time to a depth of 2,469 ft. Again no flow was obtained. The geological conditions here render a flow impossible. In 1878 a contract was made for pumping machinery and an elevated tank, and in 1879 water for fire purposes was first provided. The wells proved too small, and in 1882 a third one, 6 ins. in diameter, was sunk 800 ft. to the St. Peter

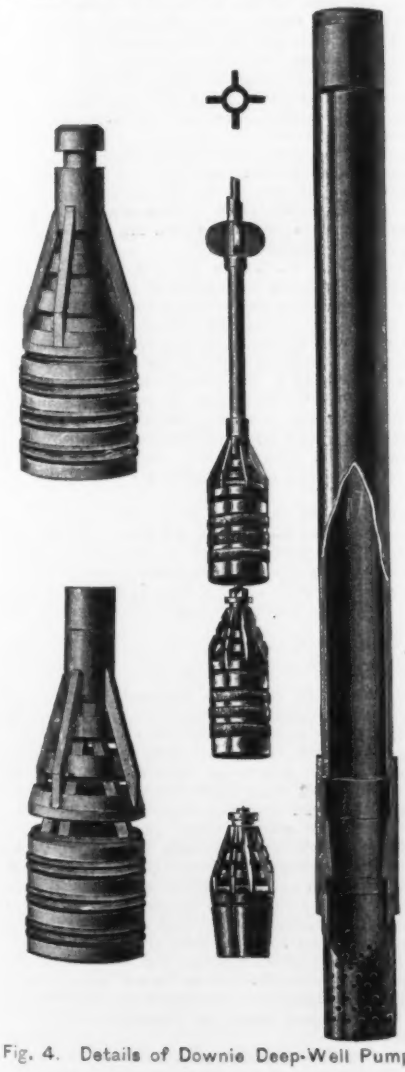


Fig. 4. Details of Downie Deep-Well Pump.

sandstone. A Deane direct-acting deep-well pump was put in to lift water from this well, and in 1890 a 22 × 100-ft. stand-pipe was erected to receive the supply so secured. The water mains now consist of about 2,500 ft. of 6-in. and 24,000 ft. of 4-in. cast iron pipe.

The cost and operating expenses of the works when Mr. Mead was called in to devise means for securing a sufficient amount of water and putting the works on a paying basis can be best expressed by the following extract from Mr. Mead's paper:

On May 29, 1893, the city clerk reported the cost of the water-works plant to be as follows:

| | | | |
|---|---|---|---|
| First well | $4,050 | Pumps, heaters, etc. | 2,790 |
| Second well | 14,450 | Hydrants and mains. | 19,385 |
| Engine, boiler and tanks | 4,279 | Interest on bonds... | 8,046 |
| Third well | 4,000 | Total | $85,000 |
| Stand-pipe | 8,000 | | |

The cost of operating the works for the two years prior to the construction of the new plant, and the average pumping record, was as follows:

| Year ending | May, '93. | May, '94. |
|---|---|---|
| Engineer and assistant | $1,140.00 | $1,581.40 |
| Repairs and supplies | 323.62 | 266.00 |
| Extra labor | 70.65 | 70.35 |
| Incidentals | 30.55 | ..... |
| Electric light | 108.53 | 113.12 |
| Coal | 1,350.71 | 2,019.80 |
| Total operating expenses | $3,023.52 | $3,850.67 |
| Revenue | 2,637.97 | 2,715.17 |
| Deficiency | $385.55 | $1,135.50 |
| Hours pumped per day | 15 | 22 |
| Gallons pumped per day | 85,200 | 98,652 |
| Cost per 1,000 galls. pumped, cts. | 9.8 | 10.8 |

Cost of coal about $2.40 per ton of 2,000 lbs.

From the above it will be seen that while the revenues were not materially increasing, the operating expenses were rapidly increasing, and the cost of pumping per 1,000 gallons had increased about 10%. The plant was in operation an average of 22 hours per day through the years 1893 and 1894, and during the warm weather it ran continuously, except when necessary to shut down for repairs. In the extremely dry summer weather it became necessary to shut off the water entirely, with the exception of an hour each at morning, noon and night, in order that water might be kept in the stand-pipe for fire purposes.

To increase the supply, the former resort to deep wells had to be continued. The old wells were inadequate, the old pumping plant was practically valueless, and, besides, it was located on the highest land in the city, requiring all coal to be hauled to it at extra expense. It was decided to put down a new well and erect a new pumping station near the crossing of the Chicago & North-

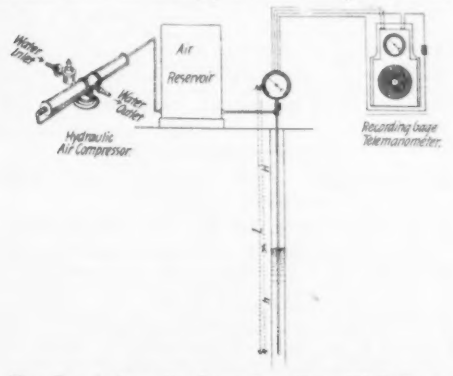



Fig. 5. Automatic Recording Deep-Well Gage.

western Ry. with the Kishwaukee River, where the ground was 855 ft. above sea level. As the well previously sunk in the Potsdam stone had not given results to warrant the extra expense incurred, it was decided to sink the new well to the St. Peter water. A contract was let to W. H. Gray & Bro., of Chicago, for a well with 14-in. casing to the rock at $4 per foot, and a 6-in. hole in the rock at $1.95 per foot. The drillers had such difficulty in sinking the 14-in. pipe that the city permitted them to reduce it to 12 ins. at a depth of 128.4 ft., from which point to rock is 32.6 ft., or 161 ft. from surface to rock. The strata encountered before reaching rock were: (1) 125 ft. of clay; (2) 20 ft. of sand, clay and quicksand; (3) 26 ft. of clay and water-bearing sand.

A covered storage reservoir was built within 30 ft. of the pump house. It is of brick, 65 ft. in diameter and 22 ft. in extreme depth, and of 500,000 gallons capacity. A wall 2 ft. thick and 6 ft. high divides the reservoir into two equal compartments. The conical truss roof is supported only by the walls.

The deep-well pump cylinder is placed 161 ft. below the surface, with a 6-in. suction pipe extending 25 ft. below it. This pump is described in the paper as follows:

In selecting a deep-well pump for the service required, much trouble was encountered in obtaining what was desired. Very little attention has apparently been given by manufacturers to developing efficient pumping machinery for raising the largest possible amount of water out of deep-bore holes, and few of the manufacturers were found who would guarantee the efficiency of their pumps. Most of the pumps offered were single-acting. That is, they performed practically all of the work on one-half of the revolution. And, to attain the capacity desired, this involved a large pump cylinder and a very uneven distribution of power. It involved also considerable loss of work in raising the long and unbalanced pump-rod at each stroke. The ordinary form of deep-well valve, consisting of a spherical brass ball seated in a ground brass seat and having a very limited rise, had not been found satisfactory at the old works, and a better arrangement of valves was also desired. Only one of the pumps offered gave any promise of the desired results, and this was offered by the Downie Pump Co. This pump consisted of a double-acting pump-head and the Downie water cylinder and patent conical valve. The valve possessed a number of admirable features, among which may be named large waterway and simplicity of construction, and it was adopted unchanged. (See Fig. 4.)

The Downie power pump-head, as originally submitted, while containing the principle most satisfactory to the writer, was not satisfactory in the details of design or construction. A modified form of the Downie pump was finally designed by the writer, built by the Downie Pump Co., and is now on trial. It is expected to give an efficiency of about 65 or 70%.

The speed of the 50-HP. motors was limited to 495 revs. per min. at 200 volts, and of the 25-HP. motor to 565 revs. at 220 volts. The motors have a guaranteed efficiency of 90% at full and 82% at half load, and must be capable of carrying 25% overload eight hours without injury.

Regarding the efficiency test of the east motor, Mr. Mead may be quoted as follows:

This motor was disconnected from the pump. A split iron pulley was fastened to the shaft for use as a brake pulley, and to this a friction brake was attached. The pulley which was furnished by the city did not fit the shaft well, and was therefore not perfectly true in circumference. For this reason it was impossible to make an absolute measurement of the maximum power of the motor; for the irregularity in the pulley rim caused the brake to become unsteady, and the weight necessary to balance it could not be determined with sufficient accuracy. Enough measurements were made, however, to give data for determining the curve of efficiency of the motors, from which the efficiencies at the limits of the capacity of the motor were calculated. The following table, which represents the average of a number of measurements, shows the results obtained:

Test of Motor on East Pump, De Kalb Pump House.

| | | | | |
|---|---|---|---|---|
| Time from | 10.34 | 10.46 | 11.38 | 2.02 |
| Time to | 10.44 | 10.56 | 11.45 | 2.18 |
| Amperes | 95.4 | 106.5 | 157 | 16⅜ |
| Volts | 218.7 | 216 | 199 | 217¾ |
| Watts | 20,864 | 23,004 | 31,243 | 3,557 |
| Electric HP. | 27.98 | 30.84 | 41.88 | 4.76 |
| Rev. of motor per min. | 399 | 396 | 402 | 379 |
| Weight on brake arm | 113 | 123 | 154 | No load. |
| Weight on brake | 35¼ | 35¼ | 35¼ | ... |
| Corrected weight | 77¾ | 87¾ | 118¾ | ... |
| Length of brake arm, ft. | 4 | 4 | 4 | ... |
| Brake HP. | 23.59 | 26.41 | 36.28 | ... |
| Efficiency, % | 84.3 | 85.63 | 86.86 | ... |

From these experiments the following approximate average efficiencies under various loads were calculated:

| HP. furnished to motor. | Calc. effic'y of motor, %. | Guaranteed efficiency, %. | HP. delivered to pump. |
|---|---|---|---|
| 25 | 83.56 | .. | 20.89 |
| 30 | 84.81 | 82 | 25.44 |
| 35 | 86.16 | .. | 30.15 |
| 40 | 87.41 | .. | 34.96 |
| 45 | 88.66 | .. | 39.90 |
| 50 | 89.81 | .. | 45.08 |
| 55 | 91.06 | 90 | 50.08 |
| 60 | 92.31 | .. | 55.39 |

From the data obtained it will be seen that it took 4.76 HP. to run the empty motor; of this 0.75 HP. was ascertained to be consumed in the field wires. The writer had the assistance of Mr. J. W. Glidden, Superintendent of the De Kalb Electrical Co., in the selection and arrangement of the electrical features of the plant.

The general character of the two main pumps is set forth by Mr. Mead substantially as follows, together with the test of the west pump, given in the accompanying table:

The approximate weight of each pump is about 18,000 lbs. The connecting rods are joined to the plungers by cross-heads, which are outside guided. All bearings are of phosphor bronze. The pinion shaft is of machine steel, is 3 ins. in diameter and runs in two bearings 12 ins. in length. The crank shaft is of forged steel, the main bearing being 6 ins. in diameter by 15½ ins. in length. The motors are coupled directly to the pinion shaft of the pumps, and the speed of the motors is reduced by proportioning the pinions and gears in the ratio of 1 to 3⅛. The gears are cut and the pinions are made of rawhide held by bronze shrouds. First-class workmanship was specified, and the Gould Co. have strictly complied with the specifications, and furnished a pair of pumps which, while solid and substantial in construction and free from vibration, are yet highly efficient. Both of the pumps were carefully tested, and the test of the west pump is given in the accompanying table.

The specified efficiency was 75% for full and 68% for half load. The latter was not reached by 1½% during the test, but has since been exceeded.

General lack of information regarding variations in the water levels of deep wells, coupled with the fact that the contract with the De Kalb Electrical Co. did not require it to operate the deep-well pump for over a 175-ft. lift, made desirable a permanent record of the water levels in the De Kalb well. The apparatus in use for this purpose is described by Mr. Mead as follows:

Test of West Triplex Pump.

| | | | | | | |
|---|---|---|---|---|---|---|
| Time from | | 9.08 | 9.58 | 10.06 | 10.38 | 11.32 | 1.16 |
| Time to | | 9.30 | 10.02 | 10.20 | 10.50 | 12.00 | 2.00 |
| Amperes | | 27.3 | 150 | 156 | 206.5 | 215.75 | 243.3 |
| Volts | | 217 | 195 | 193.4 | 195 | 192 | 186.8 |
| Watts | | 8,094 | 25,350 | 30,170 | 40,255 | 41,433 | 45,455 |
| Electric HP. furnished | | 10.85 | 33.95 | 40.44 | 53.95 | 55.54 | 60.93 |
| HP. delivered by motor | | ..... | 29.13 | 36.14 | 49.1 | 50.84 | 56.60 |
| Water pressure, lbs., No. load | | ..... | 66.5 | 84.5 | 125.5 | 126 | 129.5 |
| Suction lift, lbs. | | ..... | 4 | 4 | 4 | 4 | 4 |
| Total lift, ft. | | ..... | 70.5 | 88.5 | 129.5 | 130 | 133.5 |
| Area plungers, sq. ins. | | ..... | 78.54 | 78.54 | 78.54 | 78.54 | 78.54 |
| Length of stroke, ft. | | ..... | 1 | 1 | 1 | 1 | 1 |
| Revolutions per minute | | 43.9 | 41.75 | 41.71 | 42.5 | 42.5 | 45.93 |
| Effective HP. delivered by pump, including slip | | ..... | 20.01 | 26.27 | 39.29 | 39.44 | 43.78 |
| Combined efficiency of pump and motor, % | | ..... | 58.6 | 64.9 | 72.8 | 71.0 | 71.9 |
| Efficiency of pump, including slip, % | | ..... | 68.7 | 72.6 | 80.2 | 77.5 | 77.3 |
| Slip, % | | ..... | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 |
| Net efficiency of pump, % | | ..... | 66.6 | 70.5 | 78.1 | 75.4 | 75.2 |

The writer provided, in the specifications for deep-well pumping machinery, that a deep-well gage, either on a plan proposed on drawings furnished, or on some other approved plan, should be provided. Mr. E. E. Johnson, M. E., Mem. Wes. Soc. Eng., offered the best suggestions for such a gage. Mr. Johnson's suggestions were that by means of a small air compressor attached to the deep-well pump, air should be slowly forced through a small pipe running down the well to at least as low a point as the bottom of the pump cylinder. The pressure required to displace the water in this small pipe could then be measured by a pressure gage, and the length of the air pipe being known, the depth of water above the base of the pipe would be shown by the gage, which could be graduated, if desired, so that it would read directly in feet below the surface. The only objection to this was that no record could be kept when the deep-well pump was not running, and it was desirable to use some other motor beside the pump itself to operate the air compressor. Mr. L. B. Merriam, Mem. Wes. Soc. Eng., who superintended the construction of the plant as herein described, and whose efficient work was greatly appreicated, suggested that a Bishop & Babcock hydraulic air compressor be used for this purpose. This suggestion was also adopted. This compressor furnishes all the air necessary at a small expense for water, using about 500 gallons per day.

To make a permanent daily record of the well-gage readings, a telemanometer was purchased, the recording device of which is to be placed in the city clerk's office. (See Fig. 5.)

Mr. Mead's paper closes as follows:

From an economic standpoint, the immediate saving in expense to the city of De Kalb by the construction of the new plant is obvious, as the difference between 10.8 cts. per 1,000 gallons, the expense of pumping for 1893-4, and the present contract price of 4 cts., speaks for itself.

The economy of pumping in the way herein described, where large amounts of water are to be used and economical management is attainable, is however more than doubtful. This can be readily understood by tracing the loss of power through the system. Neglecting the matter of deep-well pumping, the loss in domestic pumping is as follows: There is first a loss of about 10% at the dynamo; an additional loss of 10% in the transmission of power from the dynamo to the motors; a loss of 16% through the motors and a loss of 32% in the pumps. This gives a net efficiency of the plant for domestic service from the power developed in the engine of only 46.27%. The efficiency for fire service is, however, about 55.28%, but fire service, of course, constitutes a very small amount of the pumping. With a steam engine equal in economy to that operated by the De Kalb Electrical Co., and the same class of pumps, but proportioned for the domestic work, the loss would not be more than 25%, the efficiency of the plant from the power developed by the engine in this case being 75%. In this case a pump for fire purposes would need to be held in reserve.

The advantage the electrical company has over a municipal power plant is in the greater economy of the larger power plant and in the advantage to be derived from good business management as compared with the ordinary municipal management. The principal advantage is, however, that they can do the necessary pumping at such times as their other business is at a minimum, and they pay nothing extra for the services of engineer and fireman, and the incidental cost of operating the power plant. The proportional extra cost of coal is probably not as large as the proportional increase in power furnished; for the numerous losses incidental to the operation of a power plant must occur in any event and are not largely increased by the additional power developed.

The writer's estimate for pumping 200,000 gallons per day with a steam pumping plant, with good management, was, including all expenses, $5.71 per day, against the contract price of $8 per day for the same amount pumped. With a greater consumption, the difference would be greater; with a smaller consumption the difference would be less, and with a consumption of 150,000 gallons or less the difference would be in favor of the electrical plant. The average consumption of water for the last three months has been but little over 100,000 gallons per day. There will doubtless be a rapid gain in consumers, however, with efficient service and a constant supply.

The cost of the new work carried out under Mr. Mead's direction, including some new mains, was as follows:

| | |
|---|---|
| Ground for pump-house and reservoir | $425 |
| Cost of well | 2,100 |
| Reservoir | 6,700 |
| Pump-house | 2,550 |
| Pumps and motors | 7,000 |
| Venturi meter | 600 |
| Water mains laid | 6,500 |
| Misc. cost, includ'g engineering and supervision | 2,000 |
| Total | $27,875 |

## REGULATING THE LEVELS OF THE GREAT LAKES.*

By G. Y. Wisner, M. Am. Soc. C. E., Detroit, Mich.

The depths of channels at the entrances of lake harbors previous to the commencement of improvement by the general government about 70 years ago, were from 2 to 8 ft., and were not generally increased to a depth of 12 ft. until after 1864. The natural channel at St. Clair flats was 11 ft. for an average stage of water, and about 13 ft. at the Lime Kiln Crossing in the Detroit River, or sufficiently greater than the depth at the principal lake ports that any slight fluctuation of the water levels in these waterways was of but little importance. The phenomenal increase in the lake commerce since 1850 has been such that all improvements of harbors and waterways which have been undertaken have generally been discounted by the increased draft of vessels built to such an extent that before such improvements could be completed, every foot of available depth has been constantly utilized, and more has been urgently asked for.

At the St. Clair flats the channel depth was increased to 13 ft. in 1871; to 16 ft. in 1873, and is now being deepened to 20 ft.; but if one may judge from the unanimous sentiment of the delegates to your Toronto convention last September, works to create a still greater depth must soon be constructed.

If such increase of depth is required at this point, and at the Sault Lock, the connecting waterways, to give unobstructed facilities for rapid and economical transportation, of necessity will require still greater depths, and since the maximum limits for these channels under the present system of improvement have been nearly reached, it becomes very important to consider new methods for securing such results.

The cost for increasing the depth of the lake waterways to 20 ft. has been about $1,500,000 for each foot, and for the principal lake harbors about $3,000,000 per foot of increase, from which it is evident that any permanent deepening of these harbors and waterways may safely be considered worth $4,500,000 for each foot in depth so obtained.

The fluctuations of the water levels of the lakes in extreme cases amount to about 5 ft. on Lakes Michigan, Huron and Erie. That these variations may be materially reduced there is no doubt, and whatever that amount may be, will increase by a like amount the low water depths of all the lake channels, and by rendering such depths nearly constant, secure much greater economy in vessel construction and transportation.

The data required for a complete investigation of this problem are not to be had at the present time, but the physical facts pertaining to the matter are sufficiently well known to determine within reasonable limits what may be accomplished, and point out the lines on which future investigations should be made.

The annual fluctuation of the water surfaces of the lakes is a function of the amount of rainfall on the respective basins, the time when such precipitation occurs, the amount of evaporation, and the outflow at the lake outlets. The development of the country substituting the lake drainage basins has undoubtedly had a modifying influence on the lake levels. In the original conditions of the lake basins the water from rains and melting snow was retained for weeks in the forest swamps before finding its way through obstructed watercourses to the lakes. With the clearing away of the forests, and the development of tile-drained farms, these swamps and reservoirs have disappeared, and the water from heavy rains is generally only a few days in finding its way into the lakes, creating rapid rises during wet seasons, and equally rapid fall of the water surfaces during droughts.

Years of heavy and evenly distributed rainfall are generally those when little evaporation occurs, while long periods of dry weather are conducive to producing a maximum evaporation from the lake surfaces. From the most reliable information we have as to the mean annual rainfall and evaporation, for the lake surfaces, the former exceeds the latter by about 1 ft. Yet, in extremely dry seasons, there is no doubt that the annual evaporation from these surfaces exceeds the amount of rainfall, in which case the discharge of the lake outlets becomes less than the drainage from the tributary watershed.

It is to this combination of conditions, working oppositely, that the extreme range of levels for different years is largely due. Years of excessive precipitation are not necessarily years of high water on the lakes, unless the times of such rainfall are so distributed as to produce a maximum effect.

The falls in St. Mary's River, at the foot of Lake Superior, make the fluctuations of that lake dependent only on conditions existing in its own drainage basin. Lake Ontario, having its outflow into the ocean directly through the St. Lawrence River, has a discharge depending on the elevation of the water surface, and inflow depending on the flow of the Niagara River, and the rainfall and evaporation on its own basin. Lakes Michigan, Huron and Erie are so connected with a system of delicately adjusted waterways that any change in the level of one of these lakes has a tendency to produce a corresponding effect in the other two.

The Straits of Mackinaw are so wide and deep that Lakes Michigan and Huron are practically the same level, except when affected by storms and unequal barometrical pressures. For a mean level of lake surfaces the difference in level from Lake Huron to Lake Erie is 8.4 ft., distributed approximately as follows:

| | Length. | Total fall. |
|---|---|---|
| St. Clair River | 41 miles | 5.4 ft. |
| Lake St. Clair | 16 " | 0.0 " |
| Detroit River | 27 " | 3.0 " |

Any change in this slope produces a corresponding change in the discharge through the waterway, and so delicate is the adjustment that the slope never varies as much as 1 ft. from the above mean, and seldom exceeds 4 ins. For mean high water of the lakes, this slope is 8.2 ft., and for mean low water, 8.6 ft., making the mean low-water slope greater than that at high water. In extreme cases, the slope at the low-water stage exceeds that at high water by nearly 1 ft., and since the discharge of any river is a function of its cross-section and slope, we have here the anomalous case of a river sometimes having its maximum discharge at its lowest stage. This is an important condition, which has not been given consideration in previous discussions of this problem, and which is really the fundamental principle which should be observed in making investigations to determine the river discharge, and in developing plans for the improvement of the waterway.

The level of Lake Erie, after reaching its maximum stage, commences to fall about one month earlier than Lake Huron and about three months before Lake Superior, showing that these lakes, when acting in their maximum natural capacity as reservoirs, are inadequate to maintain the level of the lake into which they discharge.

Lake Michigan commences to fall at the time the maximum discharge is taking place in the St. Mary's River, and sometimes falls as much as 8 ins. per month, which would correspond to an actual discharge of 320,000 cu. ft. per second in excess of the inflow from the tributary drainage basins, making a total of over 500,000 cu. ft. per second actually taken from the volume of water in Lake Michigan and Lake Huron.

Evaporation from the lake surfaces during dry favorable seasons is probably at times as much as 6 ins. per month, and in connection with the rapidly increasing slope in the St. Clair River, constitutes the principal cause of the rapid fall of the water levels of Lake Michigan and Lake Huron.

These sudden changes of level, corresponding to a rate of discharge of over 500,000 cu. ft. per second.

* Slightly condensed from a paper read at the First Annual Convention of the International Deep Waterways Association.

**Physical Data Pertaining to the Great Lakes.**

| | Superior. | Michigan. | Huron. | Erie. | Ontario. |
|---|---|---|---|---|---|
| Mean level above tide water, ft. | 601.8 | 581.3 | 581.3 | 572.9 | 246.6 |
| Maximum depth, ft. | 1,008 | 870 | 750 | 210 | 738 |
| Area sq. miles. | 31,200 | 22,450 | 23,800 | 9,960 | 7,240 |
| Area watershed, sq. miles. | 51,600 | 37,700 | 31,700 | 22,700 | 21,000 |
| Aggregate area of basin, sq. miles. | 82,800 | 60,160 | 55,500 | 32,660 | 28,840 |
| Mean annual rainfall, ft. | 2.6 | 2.8 | 2.8 | 3.1 | 2.9 |
| Variation in annual rainfall, ft. | 1.5 | 1.5 | 1.5 | 1.7 | 2.0 |
| Total rainfall on basin, cu. ft. per sec. | 187,400 | ..... | 450,350 | 547,000 | 622,700 |
| Mean annual evaporation, ft. | 1.25 | 1.8 | 1.8 | 2.0 | 2.0 |
| Max. range of levels, ft. | 3.5 | 5.0 | 5.0 | 4.1 | 4.8 |
| Average annual range of levels. | 1.20 | 1.34 | 1.34 | 1.55 | 2.07 |
| Discharge of outlets, cu. ft. per sec. | 86,000 | ..... | 225,000 | 265,000 | 300,000 |
| Do. Ruffner 1891, 1892. | ..... | ..... | ..... | 230,000 | ..... |
| Mean date of high water. | Sept. | July | July. | June. | ..... |

seem to indicate that any system of reservoirs which may be devised by damming Lake Superior, or otherwise, will be wholly inadequate to maintain the levels of the lower lakes at a stage very much higher than under existing conditions, and since the variation in the slope of the St. Clair and Detroit rivers seldom amounts to 1 ft., it would seem that the natural solution of the problem would consist in maintaining the surface of Lake Erie at as nearly a constant level as possible.

An accurate knowledge of the outflow of the lakes is absolutely essential in designing plans for regulating the lake levels. Unfortunately, such data do not exist at present, and, from some inexplicable reason, the departments having the authority to make such determinations have been very adverse to making any observation to clear up the uncertainty.

The plans and methods for improving lake harbors, inaugurated upwards of 70 years ago, are still in vogue; but, judging from the annual complaints in regard to the deterioration of channels at harbor entrances, it is evident that the limiting depths have been reached where such methods can produce permanent results.

The general plan has been to deepen the channels of connecting waterways by dredging, and at the entrance of harbors to construct parallel piers 150 to 200 ft. apart, and dredge between. This system for depths of less than 12 ft. was very effective, but for greater depths the annual silting up of channels makes the cost of maintenance very great. The width between piers is also much too small for the depth of 20 ft. or more, which must soon be obtained for all of the principal lake ports. The government has endeavored to maintain a depth of 17 ft. at these ports for several years; yet, at the opening of navigation for 1895, owing to the low stage of water in the lakes and to the silting up of channels, but few of the harbors (except on Lake Superior) had navigable channels of over 12 ft. The movement of sand parallel with shores during severe storms is enormous, and wherever these harbor channels have been excavated much deeper than the adjacent bottom of the lake, silting is almost certain to occur.

In the new channel recently cut at the entrance of Toledo harbor, the government engineer in charge reports an annual filling up of 0.5 ft.; or, assuming the average depth of the cut to be 8 ft., the work of maintenance amounts to the same as for cutting a new channel every 16 years.

When we take into consideration the fluctuations of the lake levels, it is evident that a channel 21 ft. deep at mean lake levels will not generally insure safe navigation for vessels of 20 ft. draft, except for a period of about three months each year. At the opening and closing of navigation, low water usually prevails, and vessels constructed for a full load on a 20-ft. draft will be able to carry only a part of what would be an economical load in a waterway regulated to fixed level.

The total fluctuations of the lake surfaces being over 4 ft., a well-devised system of regulation, which will reduce the range of levels to 1 ft. or less, will increase the low-water depth of all the channels 3 ft., and fix the draft for which vessels may be constructed so as to carry full loads throughout the entire season of navigation.

Two different methods have been advocated for accomplishing this result: (1) To make a regulating reservoir of Lake Superior and its tributaries, and turn their surplus waters into Lake Huron at the proper season, to maintain the low-water stage at a higher level than under the present regimen; and, (2) to regulate the level of Lake Erie with a submerged dam near the outlet of the lake, such as to increase the low-water stage about 3 ft., reduce the fluctuation to less than 1 ft., and indirectly, through the change of slope in the St. Clair River, reduce the fluctuations of the water surface of Lakes Huron and Michigan to at least one-half that at present.

With the data now at our disposal, it is impossible to state definitely what may be accomplished by either of these plans, or what the exact cost would be to complete them; but the physical facts are sufficiently well known to be able to point out in a general way the results which may be reasonably expected from the execution of either one or both of the plans, and to conclude definitely whether such an undertaking is worthy of an official investigation.

The extreme fluctuation of the water surface of Lake Superior is about 3.5 ft., with a mean fluctuation of only 1.2 ft. With proper regulating works near the foot of the lake, the low-water stage might be maintained at least 1 ft. above the present mean level, without damage to any existing structures. The extreme high stage of the lake is approximately 2 ft. above mean lake level, and to avoid all litigation for damage from overflow, the regulation should be such as to prevent this limit from being exceeded. The present outflow for mean level of lake is about 86,000 cu. ft. per second, and, with regulating works completed, the outflow could probably be increased to 150,000 cu. ft. per second for a period of three or four months each year, provided that such a discharge did not create currents in the St. Mary's River of such a nature as to make navigation difficult and dangerous. This amount could not safely be exceeded, and it is very likely the requirements of navigation would limit the maximum safe outflow at a much smaller amount. Lake Nipissing could also be utilized as a regulating reservoir, but the supply from this source would be small compared with that from Lake Superior, and it would not, therefore, be safe to estimate on a total of over 75,000 cu. ft. per second in excess of the present mean discharge of 86,000 cu. ft. Since the evaporation and outflow from Lakes Michigan and Huron sometimes amount to over 300,000 cu. ft. per second in excess of the influx from rivers and drainage, and that, too, when the discharge through the St. Mary's River is a maximum, it is quite evident that the supply from the regulating dams alone would have but little effect in checking the fall of the water surfaces of the lower lakes. It has already been shown that the discharge of the St. Clair River varies rapidly with any change of slope, and since the maintenance of a high level in Lake Huron, when that of Lake Erie is falling, will increase this slope, the St. Clair discharge would be correspondingly increased, and thus tend to prevent any beneficial results accruing from the regulating works. It would, therefore, appear that, in order to be able to secure any substantial benefit from the regulating works at the foot of Lake Superior, the level of Lake Erie must first be regulated by a dam at the head of Niagara River.

It is a well-known fact in hydraulics that where water flows over the crest of a dam or weir, any slight variation of the depth on the crest of such weir will very materially modify the volume of discharge passing over. For instnace, if the top of such a weir is 2 ft. below the general level of the water surface of a regulated lake, and a rise of 3 ins. from a heavy rain should occur, the volume of discharge over the weir would be increased 20%; or, if such were the conditions on the proposed dam for regulating the level of Lake Erie at a time when the discharge was 250,000 cu. ft. per second, corresponding to that of the present mean stage, the increase would be 50,000 cu. ft. per second, and since the increment for 1 ft. change of level at such stage is probably not far from 33,000 cu. ft. per second, the change of 3 ins. above the regulating dam would correspond to that of 1.5 ft. under the present conditions of the lake outlet.

A sudden rise of 3 ins. under the existing conditions would not increase the outflow to exceed 10,000 cu. ft. per second, from which it is evident that a properly constructed regulating dam at the foot of the lake would greatly increase the discharge of Niagara River for small rises of the lake level, and consequently lengthen the period of maximum discharge and proportionately diminish its volume of flow per second at high stage. That such a dam can be constructed there is no question; but what its dimensions should be, and what it would cost to construct it, cannot be stated until the discharge of Niagara River is accurately known.

Since the difference in the levels of the water surfaces of Lake Huron and Lake Erie seldom varies more than 6 ins. from the mean slope of the connecting waterway, it is evident that if the level of Lake Erie be so regulated as to vary but little from its present high-water stage, the annual fluctuations of water surfaces of Lakes Huron and Michigan will be decreased so much as to produce the necessary change in slope in the St. Clair and Detroit rivers, corresponding to the variation in discharge—a probable extreme fluctuation of less than 1.5 ft.

This result will directly affect the levels of the St. Mary's River below the falls, and will unquestionably add at least 2 ft. to the low-water depths of that river.

The laws governing the flow of water over the crests of dams are definitely known, and if the level of Lake Erie be determined near which it will be safe to regulate the water surface without damage to property, the problem of regulation becomes simply what length must be given to the dam, such that a fluctuation of 6 ins. on the crest will correspond to a variation in overflow equal to the maximum annual variation in the discharge of Niagara River.

The solution of this problem requires an accurate knowledge of the outflow through the Niagara River for all stages of the lake level—data which at present are so uncertain that the computed outflow by different engineers differs by amounts which would make a large river.

If this project is worthy of official investigation, the first and essential thing necessary is that the physical facts in regard to the water levels and outflow of the lakes be accurately determined. Aside from the important question under consideration, this information is badly needed to settle existing disputes as to what effect certain canal and harbor improvements are likely to have on the channel depths of the lake waterways.

With such a regulating dam in place, the annual discharge of the Niagara will be the same as under the present conditions, but at the beginning of a rise of the lake surface, the dam will add greatly to the outflow and correspondingly reduce the maximum discharge for the high-water period.

It is the opinion of the writer that such a dam will be ample to regulate the levels of Lakes Erie, Huron and Michigan, but, in case the future development of the lake commerce makes still further improvement necessary, a regulating dam at the foot of Lake Superior would place the levels of the entire upper lake waterway system under perfect control.

Since the water surface of Lake Erie, when properly regulated, will not have an annual fluctuation of over 6 ins., and since the present high-water plane of lake levels is 2.3 ft. above that of the mean stage, if the regulated plane for mean discharge be fixed at 1.5 ft. above the present mean level, the high-water stage of the regulated surface would never exceed the present high-water plane. And as it is fair to presume that all structures have been built with due regard to safety under existing conditions, no great damage could possibly arise from the improvement.

Since the fluctuation of the regular water surface will be small, all future structures can be built at heights best adapted for economical handling of freight, and have the great advantage of being in such state at all seasons of the year, a condition of affairs all shippers will appreciate.

Cheap transportation depends largely on being able to carry large quantities of freight in full loads, long distances, without change and at rapid speed. To do this, ships must be constructed with due regard to the depths of the waterways which they are to traverse, and since the capacity of a waterway within ordinary limits varies as the cube of the depth, the draft of vessel must be such as to utilize as great a depth as possible, without causing speed to be retarded by too close proximity of keel to the bottom. For waterways of constant depth, the most economical draft and tonnage for a vessel is easily determined, but where the water levels have fluctuations of several feet, the solution is very complicated and unsatisfactory.

On the lakes, freight vessels have generally been constructed for the deepest summer depth to be expected in the waterways, with the result that during low stage of water only partial loads can be carried, which, with detentions from groundings, greatly reduces the profits of the shipping business.

This convention has been convened to devise ways and means to render the cost of such transportation a minimum by setting the proper machinery in motion to have a waterway of a fixed depth of over 21 ft. constructed from the lake to tidewater; but unless some radical change is made in the methods of improving the waterways of the lakes, vessels loaded for the full navigable depth of such ship canal will be badly handicapped when chartered for ports beyond the western terminus of the canal during the low-water season on the lakes. It has already been shown that the cost of increasing the harbor channels and lake waterways has been nearly $5,000,000 for each foot in depth secured in both, and that under the present system of improvement such results have not been permanent. It would therefore appear very desirable that an investigation be made of the feasibility of increasing and rendering nearly constant the depth of navigable channels of the lakes, by regulating the lake levels, and that such investigation should be made by the International commission to be appointed, and, I understand, already provided for, to report on the character, route, and cost of a ship canal from the great lakes to the sea.

## HOW TO OBTAIN THE REPORT OF THE CROTON AQUEDUCT COMMISSION.

When the valuable illustrated report of the Croton Aqueduct Commission for the past eight years was first published, it was stated that a limited number of copies would be distributed free on application, at the discretion of the Commission, and nothing regarding the sale of the report was made public. A correspondent informed us a few days ago that he had secured a copy by direct purchase at a nominal price, and suggested that if the report was now on sale others of our readers might be interested to know it. A note addressed to Mr. A. Fteley, M. Am. Soc. C. E., Chief Engineer of the commission, brought the following reply from Mr. Fteley:

The Aqueduct Commissioners having perfected their free list of distribution of their report and receiving many applications from others, have thought it advisable to keep a certain number of copies for sale, with the idea that the book, outside of their own list, would thus reach those that are most interested in it. Their secretary has consequently issued the enclosed circular, which explains itself. The price fixed is the actual cost of the book, plus the average of express charges.

The circular is as follows:

Aqueduct Commissioners' Office, Stewart Building, 280 Broadway, New York.

Dear Sir: Your application for the report of the Aqueduct Commissioners to Jan. 1, 1895, is received.

I regret to state that it will not be possible to include your name on the list for free distribution.

If, however, you care to purchase the volume, it will be sent to you on receipt of $5.50, express charge included, provided your application reaches me before the edition is exhausted. Very respectfully,

Edward L. Allen, Secretary.

We repeat our advise, given some time ago, to every custodian of an engineering or scientific library to lose no time in securing a copy of this elaborate work.

## EFFECT OF DEPTH UPON ARTIFICIAL WATERWAYS.*

By Thomas C. Clarke, M. Am. Soc. C. E.

To ascertain the cost of transportation between Chicago and New York, by way of the Great Lakes and Erie Canal, these data are necessary: (1) The number of trips which steamers and barges can make during the season of navigation. (2) The annual cost of operating and maintaining large steamers and steam-towed barges. (3) The receipts per trip, which must be equal to the amount of the annual expenses divided by the number of trips, to prevent loss. It is assumed that the receipts per trip will be equally divided between the receipts from grain going east and merchandise going west.

The new steamer "Victory" is taken as a type of lake freighter. It is 380 ft. long by 48 ft. beam, and carries a cargo of 4,000 net tons at 14 ft. draft, 5,000 tons at 16 ft., 6,000 tons at 18 ft., and 7,000 tons at 20 ft. The economical rate of speed on the lakes, in deep water, is 13 miles an hour. Half an hour is assumed to be the time required for lockages in a ship canal, and the same for a fleet of barges. Thirteen days is estimated as the time of detention in port in all cases.

From these data the author draws the following conclusions as to the cost of transportation from Chicago to New York under the conditions mentioned:

(1) Erie Canal deepened to 18 ft., to admit steamers carrying 5,000 tons on 16 ft. draft, 5 cts. per bushel.

(2) Erie Canal deepened to 25 ft., to admit steamers of 7,000 tons burden, 3.22 cts. per bushel.

(3) Erie Canal as it now exists, 4.73 cts. per bushel.

(4) Erie Canal deepened to 9 ft., and used by fleets of one tug and five 1,500-ton steel barges loaded to 7½ ft. draft, 4.4 cts. per bushel, including transshipment at Buffalo.

(5) The detailed estimates given in the paper show that one of the heaviest charges in the third and fourth cases is the item of 1.15 cts. per bushel at Buffalo for transshipment of cargoes. If the Erie Canal were deepened to 9 ft., and its few short locks were lengthened, it would be possible to navigate the canal with fleets made up of four steel barges 180 ft. long, 17.2 ft. in beam, and loaded to 7½ ft. draft. They could be towed from Chicago to New York, and would carry a cargo of 2,400 tons, or 80,000 bushels. The cost of transportation in this case would be 2½ cts. a bushel.

It is the object of the paper to call attention to the significance of these figures, which indicate that a ship canal ought to be not less than 25 ft. deep if it be intended to pass large lake vessels, and that a slight enlargement of the Erie Canal may allow fleets of steel barges to run from New York to Chicago, transporting freight at less rates than large lake vessels could in a 25-ft. canal, even were it used free from tolls.

* Abstract (from the Society's bulletin) of a paper to be read before the American Society of Civil Engineers on Oct. 16.

## THE INTERNATIONAL DEEP WATERWAYS ASSOCIATION'S ANNUAL METING.

The first annual meeting of the International Deep Waterways Association, organized at Toronto last year, was held in Cleveland, O., on Sept. 24. The temporary chairman was Gen. Edward C. O'Brien, of the New York Dock Commission, and an address of welcome by Mayor R. E. McKisson, of Cleveland, was responded to by Mr. O. A. Howland, of Toronto, President of the International Association, on behalf of that body. Mr. E. V. Smalley, President of the St. Paul Chamber of Commerce, also responded on behalf of the American delegates. In his annual address, delivered on the evening of Sept. 24, President Howland expressed the hope that the United States and Canada would labor as comrades in the creation of new channels from the Great Lakes to the sea, and not allow international jealousy or distrust to interfere with a great work of common interest.

About 300 delegates attended the convention, and the list of officers of the Association elected, or practically re-elected, on Sept. 26, gives the names of some of the men most actively interested in this work. These officers are: O. A. Howland, Toronto, International President; L. E. Cooley, Chicago, United States Vice-President; James Fisher, Winnipeg, Canadian Vice-President; Executive Board, A. J. Crocker, Minneapolis; F. A. Flower, Superior, Wis.; Captain J. S. Dunham, Chicago; James Connell, Port Arthur; H. E. Seymour, Sault Ste. Marie; R. H. Dobell, Quebec; T. H. Canfield, Burlington, Vt.; D. M. Smith, Toledo; S. Stephenson, Menominee, Mich; E. C. O'Brien, New York; A. P. McGuirk, Davenport, Ia.; E. V. Smalley, St. Paul; A. H. Burke, Duluth; Don M. Dickinson, Detroit; Ryerson Ritchie, Cleveland; F. J. Hearne, Wheeling, and G. H. Anderson, Pittsburg. In addition to these we find the names of many prominent American and Canadian civil engineers and business men interested in promoting deeper waterways. Among the important engineering papers presented were those of Mr. T. C. Clarke, on the necessity of lessening the cost of transportation to New York; of Mr. George Y. Wisner, on the regulation of lake levels, and Mr. A. R. Smith, on the relation of New York state canals to the proposed ship canal. Mr. Thomas T. Johnston, Assistant Chief Engineer of the Chicago Sanitary District, followed Mr. Wisner on the subject of lake levels and opened an interesting general discussion upon this important topic, in which Trustees Lyman E. Cooley and B. A. Eckhart and Mr. T. Farron Henry, of Detroit, took an active part. Col. T. P. Roberts, in another paper, advocated the conversion of the Erie Canal into a ship canal; Prof. George Tunell, of the Chicago University, discussed the effect of deep water between the lakes and the sea upon domestic shipbuilding; Prof. L. M. Haupt advocated the superiority of waterways over railways in providing cheap transportation, and Mr. Joseph R. Oldham read a paper entitled "Is a Type of Vessel to Navigate Fresh and Salt Water Practicable?"

The paper of Mr. Wisner is given, practically in full, in another part of this issue. Mr. Johnson heartily favored general regulation and control over the level of the lakes as a necessity to prevent the waste of money on public improvements. This regulation will increase low-water navigable depths in the several lakes to the amount of several feet and at all times render the depths more uniform. But besides this creation of new conditions, the natural hydraulic conditions of the upper basin of the lakes must be carefully studied and, if possible, preserved. Forests are giving way to farms; more rainfall is being absorbed by vegetation, and the rainfall itself, or the proportion of rainfall that reaches the lakes, rather than the skies, by evaporation, is also undergoing a change. Mr. Johnson said that if the cost of such control does not exceed $5,000,000, it would be small in comparison with the benefits to follow. Mr. Lyman E. Cooley, in discussing the possible change of 3 to 6 ins. in lake level by reason of the drainage canal, said that in 1886 the general lake level was 4 ft. higher than it is now; a temporary decrease due to natural causes, and in comparison with which the proposed outflow is insignificant. He also emphasized the fact that the contemplated and demanded deepening of channels to 20 ft. also absolutely required the control and regulation of the level of the Great Lakes. In times past the appropriation of a part, or the whole, of the waters from lakes and rivers for feeding canals had been deemed customary, right and proper. But when canals of the dimensions here proposed are in question, you go beyond existing conditions and the matter becomes one of international importance and interest.

Mr. Alexander E. Smith favored an improved 9-ft. Erie Canal, practically on the plans of the State Engineer of New York, as a substitute for a ship canal; and he claimed that with the lake ports deepened to conform with the deeper channels, there would be a reduction of 33% in the cost of transportation over present rates. He stated that if engineers could figure out any use for a ship canal, for canal barges to compete, at ¾ cts. per bushel, or 15 cts. per ton, against ships navigating this canal, he would like to see the figures. With a 20-ft. ship canal, costing $200,000,000, the lowest present estimate, a traffic of 12,000,000 tons per annum would require a toll of 6⅔ cts. per ton to pay interest on the investment alone. Even with 24,000,000 tons traffic, the toll would be 3⅓ cts. per ton; and with double locks, which such a traffic would demand, the cost of the canal would be enormously increased. The interest on the $200,000,000 at 4% would pay for the transportation of 60,000,000 tons of freight from Buffalo to New York on a 9-ft. Erie Canal, if such a canal or its duplicate could carry it. And if the entire 40,000,000 tons of merchandise now moved on the Great Lakes were to use a ship canal, with suitable dimensions in width and locks costing $500,000,000 at a conservative estimate, the interest at 4% would require a toll of 50 cts. per ton on every ton. Mr. Smith went into much detail of the present Erie Canal service to illustrate his contention that a 9-ft. canal, with improved and enlarged locks, using 7-ft. barges, would fulfill requirements better than any ship canal of 20 ft.

Mr. Joseph R. Oldham took up the very practical question of the type of vessel suitable for navigating both fresh and salt water. He thought a large screw steamer could be designed that would answer fairly well; but he knew of no existing lake steamer strong enough for the fall and winter trade between New York and England. But navigation on both lakes and canal would be closed during our severe winters; and if a fleet of 500,000 tons were built for ocean traffic, at a cost of about $30,000,000, the loss by depreciation and inactive capital would amount to at least $1,800,000 per annum. Mr. Oldham thinks that the vessels would also deteriorate quite as fast while lying up in this frigid climate as they would while at work; and he sees no profit in the suggested innovation. It must not be forgotten, he remarked, that as soon as a deep waterway was opened to the sea our steamers would come in direct competition with foreign vessels; and in this competition the first cost of construction will be an important factor. The lake steamer could not have the draft suitable for ocean trade; and it is a rule in shipbuilding that the deep ship is the cheapest type, and the ship broad of beam costs the most proportionally.

Prof. Emory R. Johnson, of the University of Pennsylvania, read a paper upon the "Effect of Deep Water between the Great Lakes and the Sea upon Railway Traffic and Profits." He claimed that the experience along the route of the Erie Canal and the development of the St. Lawrence prove that the existence of a ship canal of 20 or 26 ft. in depth on the lines proposed would vastly increase the traffic between the sea and the great lakes and the Northwest; and in this increase and economic development the railways would inevitably share. Mr. William Livingston, President of the Lake Carriers' Association, of Detroit, advocated deeper harbors and channels. He had faith in the engineers of the country, and advised them to go ahead and carefully prepare their estimates of cost, and he was assured that when they would lay these estimates before the Association at some future time, a great deal of the present excitement would be allayed, and the subject could be then attacked from a business standpoint, with a full knowledge of the relief sought, and what it would cost. Among other papers presented were the following: "The Necessities and Advantages of a Ship Canal from the Great Lakes to the Oceans," by Dennison B. Smith, Secretary of the Toledo Produce Exchange; "The Volume and Value of Commerce Tributary to an Enlarged Waterway System," by James Fisher, of Winnipeg, Man.; and "The Ultimate Effect of Deep Water from the Great Lakes to the Sea on Iron and Steel Manufacture," by Arthur J. Moxham, President of the Johnson Iron & Steel Co., Cleveland; and Prof. Lewis M. Haupt, A. M., of Philadelphia, on "Sectionalism and Railways versus Deep Waterways."

**The "circlograph" is an instrument for drawing and measuring circular curves of any large radius without requiring the center. It was exhibited by Mr. T. Clarkson at a recent meeting of the Royal Society, in London. The construction of the instrument, as described in "The Engineer," is based upon a recent discovery that it is possible to cut a flat piece of steel into a certain form which imparts to it the property of always bending into circular curves. The plate, of uniform thickness and temper, and for curves of, say, 12 ins. radius, is made straight upon one of the long edges, the ends are squared and the top edge is then cut into the approximate form of a hyperbola, of which the long straight-edge is a symmetrical chord. Such a plate, bent by end compression, gives a circular curve. The instrument itself is made of two hinged bars, with the steel plate between the open end of the V. A screw draws the bars together, and a pair of levers working on top of the V can be set to the radius of the curve wanted, so as to measure the radius of a given arc.**

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5 OCT 1895



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## PERSONALS.

Mr. Alexander E. Abend, City Engineer of East St. Louis, Ill., shot and killed himself on Sept. 18.

Mr. W. L. Hickman, of Cedartown, Ga., General Manager of the North Georgia Iron Co., was accidentally killed by a train near Cedartown recently.

Mr. W. K. Gibson, Chief Engineer of the Dayton Coal & Iron Co., of Dayton, Tenn., has been appointed General Manager, succeeding Mr. D. Jamme, resigned.

Mr. Edward Goodwin, a graduate of the School of Mines of Columbia College, has been appointed Professor of Mining and Geology in the University of Idaho, at Moscow, Idaho.

Mr. Frank H. Constant, until recently Assistant Engineer with the Osborn Co., civil engineers, of Cleveland, O., has accepted a position as Instructor in Civil Engineering in the University of Minnesota at Minneapolis, Minn.

Mr. Geo. W. Creighton, Superintendent of the Sunbury Division of the Philadelphia & Erie R. R., has been appointed to the superintendency of the Middle Division of the Pennsylvania R. R., to succeed Mr. Frank Ellmaker, resigned.

Mr. Frank Ellmaker, Superintendent of the Middle Division of the Pennsylvania R. R., with headquarters at Harrisburg, Pa., has resigned his position in order to accept that of General Superintendent of the Consolidated Traction Co., of Newark, N. J.

Mr. C. D. Purdon has been appointed Principal Assistant Engineer of the Atchison, Topeka & Santa Fe R. R., with headquarters at Topeka, Kan. Mr. C. A. Morse has been appointed Resident Engineer on the Chicago Division, in place of Mr. Purdon.

Mr. Russell R. Stuart, who has been nominated for State Engineer and Surveyor of New York on the Democratic ticket, was born in Hamburg, N. Y. He entered the engineering service of the Erie Canal in 1880, and was appointed Division Engineer by Mr. Schenck in 1891, which position he held until Mr. Schenck went out of office. He is 48 years of age.

Mr. Geo. H. Vaillant, well known in railway circles, died on Sept. 30, aged 55 years. He began railway work as a boy in the Chicago offices of the Lake Shore & Michigan Southern R. R., and remained with that company for 28 years. About 10 years ago he became Traffic Manager of the New York, Lake Erie & Western R. R., and later became Vice-President, which office he held until his health failed.

Mr. M. Geary, President of the Snow Pump Works, of Buffalo, N. Y., and also President of the Oil City Tube Co. and the Oil City Boiler Works, of Oil City, Pa., died suddenly in New York city Sept. 18 at the age of 51. He located in Oil City in 1876, and, in company with B. W. Vandergrift and Daniel O'Day, started the Oil City Boiler Works. Later he formed the Oil City Tube Co., which owns one of the largest pipe mills in the country.

Prof. Eli Whitney Blake, late Hazard Professor of Physics at Brown University, died at Hampton, Conn., on Oct. 1. He was born in New Haven, Conn., April 20, 1836, and graduated from Yale in 1857. He then spent two years in the Sheffield Scientific School and several years in Europe studying physics at Heidelberg, Marburg and Berlin. Returning to this country, he was made Professor of Chemistry and Physics in the University of Vermont, and from 1868 to 1870 he was Professor of Physics and Mechanic Arts at Cornell University, acting part of this time as Professor of Physics at Columbia College. From 1870 until June, 1895, he filled the chair of physics at Brown University.

Louis Pasteur, the chemist, physicist and eminent biologist, whose death has just been announced, was born at Dole, France, in 1822. He was educated at the Ecole Normale, of Paris, and early began the study of chemistry and molecular physics under Dumas, Balard and Delafosse. On graduating, he was appointed Assistant Professor of Physics at Strasburg; in 1854 he was Dean of the faculty of science at Lille, and he here began the experiments which afterwards made him famous. The staple industry of Lille was distilling, and his first researches were in the domain of fermentation, and his discoveries in that line have been exceedingly valuable to that industry. Somewhat later he took up the study of bacterial life and the saving of animal life by an inoculation that produced a mild form of the disease in question. He is said to have saved millions of sheep by inoculation with the attenuated virus of splenic fever. About the same time he made his remarkable experiments upon persons bitten by mad dogs, using in this case the poison producing rabies. His careful study of bacteria has revolutionized previously conceived ideas on this subject, especially in the bacteria of diseases. Pasteur has exercised a widespread influence upon the progress of science throughout the latter half of this century. He was a member of the French Academy, succeeding M. Littre.

Col. Orlando M. Poe, Corps of Engineers and Brevet Brigadier General, U. S. A., died at his home in Detroit on Oct. 2. Colonel Poe was born in Ohio about 60 years ago, and was appointed from that state to the Military Academy at West Point on Sept. 1, 1852. He graduated on Oct. 1, 1856, as a Brevet Second Lieutenant of Topographical Engineers, and served until 1861 on the survey of the Great Lakes. During the Civil War he was at first Chief Topographical Engineer of the Department of the Ohio, but on Sept. 16, 1861, he became Colonel of the 2d Michigan Volunteers, doing service in the Army of the Potomac and in North Virginia. From Nov. 29, 1862, to March 4, 1863, he was a Brigadier General of Volunteers. On March 3, 1863, he was made a Captain of Engineers in the Regular Army, and was detailed as Chief Engineer of the Department of Kentucky. He was in active service in the West and South to the close of the war, participating in many battles and marching with Sherman from Atlanta to Savannah, and was present at the surrender of Gen. J. E. Johnson at Durham Station, N. C., on April 26, 1865. He was breveted four times for gallant and meritorious service in the field, and at the close of the Civil War he was a Brevet Brigadier General in the U. S. Army. On March 7, 1867, he became a Major of Engineers, and was made a Colonel of Engineers on July 23, 1888. Colonel Poe has been engaged in the duties of his corps in many parts of the United States, but since 1883 he has been in practically continuous charge of the improvement of the upper lakes, and especially of the St. Mary's Falls canal and locks, now approaching completion. Colonel Poe was a member of a number of boards of engineers on river and harbor improvement, and ranked among the foremost men of his profession in this country.

## ENGINEERING SOCIETIES.

### COMING TECHNICAL MEETINGS.

ENGINEERING CLUB OF COLUMBUS, O.
Oct. 5. Secy., David Buell.
ENGINEERS' CLUB OF PHILADELPHIA.
Oct. 5. Secy., L. F. Rondinella, 1122 Girard St.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 8. At Atlanta, Ga. Secy., R. W. Raymond, New York, N. Y.
ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 8. At St. Louis, Mo. Secy., W. W. Sharpe, Waycross, Ga.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Oct. 8. Secy., F. A. Coburn, Case Library Building.
DENVER SOCIETY OF CIVIL ENGINEERS.
Oct. 8. Secy., H. Breen, 36 Jacobson Block.
NORTHWEST RAILWAY CLUB.
Oct. 8. Secy., G. A. Seley, 80 Metropolitan Block, St. Paul, Minn.
NORTHWESTERN SOCIETY OF ENGINEERS.
Oct. 8. Secy., D. W. McMorris, Burke Bldg., Seattle, Wash.
WISCONSIN POLYTECHNIC SOCIETY.
Oct. 8. Secy., W. K. Means, Loan & Trust Bldg., Milwaukee.
NEW ENGLAND RAILROAD CLUB.
Oct. 9. Secy., F. M. Curtis, P. O. Box 1570, Boston, Mass.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Oct. 10. Secy., C. H. McLeod, Montreal.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Oct. 10. Secy., G. L. Annan, City Engineer's Office.
ENGINEERING SOCIETY OF WESTERN NEW YORK.
Oct. 10. Secy., Geo. R. Sikes, 122 Pearl St., Buffalo, N. Y.
ENGINEERS AND ARCHITECTS' CLUB OF LOUISVILLE.
Oct. 10. Secy., Jas. K. Zollinger, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
Oct. 10. Secy., H. D. Rubin, Nashville, Tenn.
INDIANAPOLIS ENGINEERING CLUB.
Oct. 12. Secy., C. C. Brown, City Engineer.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Oct. 12. Secy., Forrest J. Smith, Denver Block, Helena, Mont.
ENGINEERS' CLUB OF KANSAS CITY.
Oct. 14. Secy., F. W. Tuttle, Baird Building.
AM. SOCIETY OF RAILROAD SUPERINTENDENTS.
Oct. 14. Annual meeting at New York. Secy., C. A. Hammond, 143 Liberty St., New York.
COLUMBIAN ENGINEERING SOCIETY.
Oct. 15. Secy., W. F. Hart, University Building, 15th and H Sts. N. W., Washington, D. C.
AMERICAN INT. ASSOC. OF RY. SUPTS. OF BRIDGES AND BUILDINGS.
Oct. 15. At New Orleans, La. Secy., S. F. Patterson, Boston & Maine R. R., Concord, N. H.
AMERICAN STREET RAILWAY ASSOCIATION.
Oct. 15. At Montreal, Que. Secy., John N. Partridge, Brooklyn, N. Y.
AMERICAN INSTITUTE OF ARCHITECTS.
Oct. 15, 16, 17. Annual convention, at St. Louis, Mo. Secy., Alfred Stone, Providence, R. I.
WESTERN RAILWAY CLUB.
Oct. 15. Secy., W. D. Crosman, Rookery Bldg., Chicago.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Oct. 16. "Effect of Depth Upon Artificial Waterways," by Thomas C. Clarke. Secy., C. W. Hunt, 127 E. 23d St., New York city.
ENGINEERS' CLUB OF ST. LOUIS.
Oct. 16. "Sewerage of Indianapolis," by C. C. Brown. Secy., W. H. Bryan, Turner Block.
AMERICAN RAILWAY ASSOCIATION.
Oct. 16. At New York. Secy., W. F. Allen, 24 Park Place, New York.
ENGINEERS AND ARCHITECTS' ASSOCIATION OF SOUTHERN CALIFORNIA.
Oct. 16. Secy., F. Van Vleck, Los Angeles, Cal.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Oct. 16. Secy., S. E. Tinkham, City Hall, Room 36, Bromfield St.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 16. Secy., J. A. Pilcher, Roanoke, Va.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Oct. 16. Secy., R. W. Pope, 26 Cortlandt St., New York.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Oct. 17. Secy., D. Carhart, Carnegie Library Bldg., Allegheny.
ENGINEERS' CLUB OF CINCINNATI.
Oct. 17. Secy., J. F. Wilson, Odd Fellows' Temple.
NEW YORK RAILROAD CLUB.
Oct. 17. Secy., John A. Hill, 256 Broadway, N. Y.
ENGINEERS' CLUB OF MINNEAPOLIS.
Oct. 21. Secy., E. Nexson, Kasota Block.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Nov. 1. Secy., O. H. Von Geldern, 819 Market St., San Francisco.
WESTERN SOCIETY OF ENGINEERS.
Nov. 6. Secy., Chas. J. Roney, 1736 Monadnock Block, Chicago, Ill.
CENTRAL RAILWAY CLUB.
Nov. 8. Secy., H. D. Vought, Buffalo "Courier," Buffalo, N. Y.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 21. Secy., C. A. Charpiot, Macon, Ga.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Dec. 13. Secy., D. W. Meeker, St. Paul, Minn.

WESTERN SOCIETY OF ENGINEERS.—At the meeting of the Society, held Sept. 24, it was announced that the recent letter ballot had resulted in favor of withdrawal from the Association of Engineering Societies. The vote stood 179 in favor of withdrawal, and 87 against such action. The next meeting is to be held in the Society's rooms in the Monadnock Block, Oct. 2. A discussion on the "Proper Chemical Composition of Steel for Heavy Rail Sections," will be opened by Mr. Robert W. Hunt. On Oct. 12 an excursion along the line of the Chicago Drainage Channel is announced by the entertainment committee.

AMERICAN INTERNATIONAL ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.—At the convention of the Association, to be opened at New Orleans, La., Oct. 15, reports on the following subjects will be presented for discussion: "Mechanical Action and Resultant Effects on Bridges of Locomotives at High Speeds," "Methods and Special Appliances for Building Temporary Trestles Over Washouts and Burnouts," "Strength of Various Kinds of Timber Used in Trestles and Bridges, with Especial Reference to Southern Yellow Pine, Fir, White Pine and Oak," "Best Method of Erecting Plate Girder Bridges," Best and Most Economical Railway Track Pile Driver," "Sand Driers, Sand Elevators, and Best Methods of Supplying Sand to Locomotives," "Span Limits for Different Classes of Iron Bridges; Comparative Merits of Plate Girder and Lattice Bridges for Spans from 50 ft. to 110 ft.," "Best Methods of Spanning Openings Too Large for Box Culverts when Embankments are Too Low for Arch Culverts," "Best Form of End Construction for Trestles Adjoining Embankments," "Interlocking Signals," "Pumps and Boilers."

NEW ENGLAND ROADMASTERS' ASSOCIATION.—The 13th annual convention was held at the Revere House, Boston, Mass., Sept. 18 and 19. At the first meeting, with the President, Mr. R. P. Collins in the chair, the Treasurer's report was read, showing a balance of $393, and officers were elected as follows: President, A. C. Stickney, Boston & Maine R. R.; Vice-President, C. C. Elwell, New York, New Haven & Hartford R. R.; Secretary and Treasurer, M. C. Hamilton, New York, New Haven & Hartford R. R.; Chaplain, R. Hiland, Fitchburg R. R.; Executive Committee, W. E. Clark, Boston & Maine R. R.; E. H. Bryant, New York, New Haven & Hartford R. R.; C. B. Lentell, Boston & Albany R. R.; P. A. Eaton, Boston & Maine R. R.

At the afternoon session some of the committee reports were presented, and Mr. C. C. Elwell, Roadmaster of the New York Division of the New York, New Haven & Hartford R. R., read a paper on "Maintenance of Way on English Railways," illustrated by drawings of English track. On Sept. 19 the other committee reports were presented and discussed, and in the evening there was a banquet. On Sept. 20 an excursion was made to Plymouth and Nantasket, at which latter place the electric railway was inspected. Abstracts of the committee reports are given in another column.

THE AMERICAN SOCIETY OF IRRIGATION ENGINEERS.—The third annual meeting of the society was held at Albuquerque, N. M., on Sept. 16, 17 and 18. Members and visitors were present from some 10 states and territories, from the District of Columbia, from Ontario and the Northwest Territory of Canada, and from the Republic of Mexico. Mr. William Pearce, of Calgary, N. W. T., was made President pro tem. The Treasurer reported, for the year from Sept. 8, 1894, to

Sept. 16, 1895, as follows: Receipts from all sources, $676; expenditures, $568; balance, $108. The election, by letter ballot, for officers for the ensuing year, resulted as follows: President, Wm. Ham. Hall, 511 Mills Building, San Francisco, California; Vice-President, Walter H. Graves, Crow Indian Agency, Montana; Secretary and Treasurer, John S. Titcomb (re-elected), Denver, Colo.

Sessions of the society were held on each of the days above named, and a number of papers were presented and referred to the board of directors, and several members gave notice of papers for the "Quarterly."

The following resolution was adopted:

Resolved, That the Board of Directors be instructed to arrange to hold our annual meetings at a different date from that of the International Irrigation Congress, and to take the necessary steps to ascertain the feeling of the members as to the advisability of establishing a permanent headquarters for the society, where the annual meetings shall be held.

Mr. Walter Pearl, Denver, Colo., submitted designs for a certificate of membership, for a badge, and for a button for the society.

The Secretary was instructed to return the thanks of the society to Mr. Pearl, and to send the cards with the designs furnished by him to the members of the society, for their opinions and suggestions; and the Board of Directors were instructed to select and adopt designs for a certificate of membership, and for either a badge or a button, after a reasonable time has been given to receive such opinions and suggestions.

John S. Titcomb, Secretary.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Sept. 18, Mr. A. L. Johnson opened the discussion on "The Inspection of Structural Steel." He stated the ordinarily-accepted definitions of the terms "elastic limit," "yield-point," and "break-down point," and showed the extreme difficulty of determining these characteristics, particularly with very high-grade steel, such as is used in drawn wire. He doubted whether any existing method gives an exact determination of these points, and also doubted whether it was necessary to know them, as the ultimate strength and elongation tell all that is really essential to know about any material. In his opinion, advanced practice would warrant the omission of the elastic limit in all specifications.

Mr. Robt. Moore agreed fully with Mr. Johnson. The elastic limit being uncertain and difficult of determination, he had for some years omitted it entirely from his specifications.

Prof. J. B. Johnson called attention to the fact that for all commercial purposes the three points, elastic limit, yield-point, or break-down point, were one and the same, and need only be considered separately in an abstract scientific study of the subject. He showed charts from tests recently made by Professor Grey at Terre Haute, made on what is perhaps the best apparatus in existence for the purpose. They showed a practically straight line from the origin to the yield-point.

Mr. Bryan thought the elastic limit should not be lost sight of, for the reason that it, and not the ultimate strength, indicates what could be done with a material. It is important to know when the structure will begin to distort seriously, rather than when it will fail altogether. He thought it would be better to use reduced factors of safety, based upon the yield-point rather than the ultimate strength. In reply, Mr. Moore stated that the ultimate strength and elongation were properties which could be readily and accurately determined, and that in all standard materials the elastic limit bore a certain relation to the ultimate strength, which relation did not vary materially.

President Russell called attention to the difficulty which the designing engineer met with in using the accepted formulas when so much uncertainty existed as to the elastic limit. William H. Bryan, Secy.

## CONSTRUCTION NEWS.

### CONDENSED LIST OF CONTRACTS PENDING WITH DATE OF OPENING BIDS.

| Bids to be opened. | Work. | Place. | See Eng. News. |
|---|---|---|---|
| Oct. 4. | Bridge superstructure, | Franklin, Pa. | Sept. 19 |
| Oct. 4. | Water-works system, | Peotone, Ill. | Sept. 19 |
| Oct. 4. | Macadamizing, | Stapleton, N. Y. | Sept. 19 |
| Oct. 4. | Highway bridge, | Stapleton, N. Y. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 and 26. | | |
| Oct. 4. | Pipe sewers (4,800 ft.), | McKees Rocks, Pa. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 and 26. | | |
| Oct. 4. | Brick sewers, | McKees Rocks, Pa. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 and 26. | | |
| Oct. 4. | Canal improvements, | Albany, N. Y. | Sept. 26 |
| Oct. 4. | Pig lead, | Baltimore, Md. | Sept. 26 |
| Oct. 4. | Removal of wreck, | Philadelphia, Pa. | Sept. 26 |
| Oct. 4. | Repaving two streets, | Buffalo, N. Y. | Sept. 26 |
| Oct. 4. | Bridge superstructure, | Fairport, N. Y. | Sept. 26 |
| Oct. 4. | Granite block paving, | Boston, Mass. | Oct. 3 |
| Oct. 4. | Brick paving, | Cincinnati, O. | Oct. 3 |
| Oct. 5. | Stone road, | Farmington, Conn. | Sept. 26 |
| Oct. 5. | School building, | Norwood, O. | Sept. 12 |
| Oct. 5. | Reservoir, | Oberlin, O. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19. | | |
| Oct. 5. | Macadam road, | East Hartford, Conn. | Sept. 26 |
| Oct. 5. | Portable water tower, | Cincinnati. | Sept. 26 |
| Oct. 5. | Sewer, | Sandusky, O. | Sept. 26 |
| Oct. 5. | Asphalt paving, | Indianapolis, Ind. | Sept. 26 |
| Oct. 5. | Bridge, | Ecorse, Mich. | Oct. 3 |
| Oct. 5. | Pipe sewer, | Dubuque, Ia. | Oct. 3 |
| Oct. 5. | Macadam paving, | Dubuque, Ia. | Oct. 3 |
| Oct. 7. | Bridges (2), | Oklahoma City, Okla. | Oct. 3 |
| Oct. 7. | Macadamizing, | Van Wert, O. | Sept. 19 |
| Oct. 7. | Bridges (2), | Leavenworth, Kan. | Sept. 19 |
| Oct. 7. | Iron bridge, | Brookings, S. Dak. | Sept. 19 |
| Oct. 7. | Bridges, | New Berne, N. C. | Sept. 19 |
| Oct. 7. | Piles (5,500), | at Fort Delaware, Del. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 to Oct. 3. | | |
| Oct. 7. | 20-in. cast iron pipe (120 ft.), | Baltimore. | Sept. 26 |
| Oct. 7. | Sewer system, | Wausau, Wis. | Sept. 26 |
| Oct. 7. | Granite block paving, | Albany, N. Y. | Sept. 26 |
| Oct. 7. | Pipe sewers, | Albany, N. Y. | Sept. 26 |
| Oct. 7. | Steel bridge, | Natchez, Miss. | Sept. 26 |
| Oct. 7. | Bridges, | Sherman, Tex. | Oct. 3 |
| Oct. 7. | Asylum buildings, | Boston, Mass. | Oct. 3 |
| Oct. 7. | Pipe sewers, | Rutland, Vt. | Oct. 3 |
| | Advertised, Eng. News, Oct. 7. | | |
| Oct. 7. | Pipe sewers, | Bath-on-Hudson, N. Y. | Oct. 3 |
| Oct. 7. | Pipe sewers, etc., | Rochester, N. Y. | Oct. 3 |
| Oct. 7. | Granite block paving, | Albany, N. Y. | Oct. 3 |
| Oct. 7. | Granite block paving, | Cincinnati, O. | Oct. 3 |
| Oct. 7. | Cobblestone paving, | Goshen, Ind. | Oct. 3 |
| Oct. 7. | Improving streets, | Duluth, Minn. | Oct. 3 |
| Oct. 7. | Hotel, | Greenfield, Ind. | Oct. 3 |
| Oct. 7. | Sewer, | Lawrence, Kan. | Oct. 3 |
| Oct. 7. | Pipe sewers, | Albany, N. Y. | Oct. 3 |
| Oct. 8. | Water-wks system, | Grand Junction, Col. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 to Oct. 3. | | |
| Oct. 8. | Hydrants (20), | Winnipeg, Man. | Sept. 26 |
| Oct. 8. | Iron bridge, | Tell City, Ind. | Sept. 26 |
| Oct. 8. | Asylum buildings, | Boulder, Mont. | Sept. 26 |
| Oct. 8. | Repairing bridge, | Oswego, Kan. | Sept. 26 |
| Oct. 8. | Wagon road, | Bozeman, Mont. | Sept. 26 |
| Oct. 8. | Iron bridges (5), | Beatrice, Neb. | Sept. 26 |
| Oct 8. | Belgian block paving, | Jersey City, N. J. | Sept. 26 |
| Oct. 8. | Naval supplies for Port Royal, S. C. | | Oct. 3 |
| Oct. 8. | New conduit, etc., | Buffalo, N. Y. | Oct. 3 |
| Oct. 8. | Concrete reservoir wall, | Philadelphia. | Oct. 3 |
| Oct. 8. | Water-works system, | Royal Center, Ind. | Oct. 3 |
| Oct. 8. | Court house work, | Minneapolis, Minn. | Oct. 3 |
| Oct. 8. | Sewers, | Chicago, Ill. | Oct. 3 |
| Oct. 8. | Sewers, | Neenah, Wis. | Oct. 3 |
| Oct. 8. | Brick paving, | Jersey City, N. J. | Oct. 3 |
| Oct. 8. | Electric railway, | New Philadelphia, O. | Oct. 3 |
| Oct. 9. | Paving, | Ansonia, Conn. | Sept. 26 |
| | Advertised Eng. News, Sept. 26. | | |
| Oct. 9. | Brick paving, | Cleveland, O. | Sept. 19 |
| Oct. 9. | Sale of canal, | Annapolis, Md. | Aug. 22 |
| Oct. 9. | Water-works crib, | Cleveland, O. | Sept. 12 |
| Oct. 9. | Traveling cranes (2), | Cleveland, O. | Sept. 12 |
| Oct. 9. | Mechanical stockers, | Cleveland, O. | Sept. 12 |
| Oct. 9. | Dimension block paving, | Ansonia, Conn. | Sept. 26 |
| | Advertised, Eng. News, Sept. 26. | | |
| Oct. 9. | Disinfecting plant at San Diego, Cal. | | Sept. 26 |
| Ort. 9. | Water-works system, | Grove City, Minn. | Oct. 3 |
| Oct. 9. | Water-works system, | Belton, Tex. | Oct. 3 |
| Oct. 9. | Electric lighting, | Blackstone, Mass. | Oct. 3 |
| Oct. 9. | Repairing building, | New York, N. Y. | Oct. 3 |
| Oct. 9. | Pipe sewer, | Des Moines, Ia. | Oct. 3 |
| Oct. 9. | Macadamizing, | Southington, Conn. | Oct. 3 |
| Oct. 9. | Paving, | Brooklyn, N. Y. | Oct. 3 |
| Oct. 9. | Flagging, | Brooklyn, N. Y. | Oct. 3 |
| Oct. 9. | Telford paving, | New York, N. Y. | Oct. 3 |
| Oct. 9. | Asphalt paving, | New York, N. Y. | Oct. 3 |
| Oct. 9. | Macadamizing, | Columbus, O. | Oct. 3 |
| Oct. 9. | Macadamizing, | Depew, N. Y. | Oct. 3 |
| | Advertised, Eng. News, Oct. 3. | | |
| Oct. 10. | Pipe sewers (7,084 ft.), | Warren, O. | Sept. 19 |
| Oct. 10. | Pipe sewers, | Scottdale, Pa. | Sept. 26 |
| | Advertised, Eng. News, Sept. 26 and Oct. 3. | | |
| Oct. 10. | Macadamizing, | New Milford, Conn. | Sept. 26 |
| Oct. 10. | Main sewer, | Carbondale, Pa. | Sept. 26 |
| | Advertised, Eng. News, Sept. 26 and Oct. 3. | | |
| Oct. 10. | Steel bridge, | Delaware, O. | Sept. 26 |
| Oct. 10. | Pier work, | New York, N. Y. | Oct. 3 |
| Oct. 10. | Steel bridges (2), | Phillipsburg, Kan. | Sept. 26 |
| Oct. 10. | Stone arch bridge, | Winona, Minn. | Oct. 3 |
| Oct. 10. | Court house, | Huntington, W. Va. | Oct. 3 |
| Oct. 10 | Macadam road, | Old Saybrook, Conn. | Oct. 3 |
| Oct. 10. | Macadam road, | New Milford, Conn. | Oct. 3 |
| | Advertised, Eng. News, Oct. 3. | | |
| Oct. 10. | Cement sidewalks, | Milton, Ind. | Oct. 3 |
| Oct. 10. | Bulkhead wall, | Brooklyn, N. Y. | Oct. 3 |
| | Advertised, Eng. News, Oct. 3. | | |
| Oct. 10. | Fire hose, | Boston, Mass. | Oct. 3 |
| Oct. 11. | Heating and ventilating, | Columbus, Ga. | Oct. 3 |
| Oct. 11. | Sewers (17,000 ft.), | Sharon, Pa. | Oct. 3 |
| | Advertised, Eng. News, Oct. 3. | | |
| Oct. 12. | River improvements, | Richmond, Va. | Sept. 26 |
| Oct. 12. | Asphalt paving, | Indianapolis, Ind. | Sept. 26 |
| Oct. 12. | Water-works system, | Delhi, N. Y. | Oct. 3 |
| Oct. 12. | Cement sidewalks, | Avondale, O. | Oct. 3 |
| Oct. 12. | Brick paving, | Sandusky, O. | Oct. 3 |
| Oct. 12. | Pipe sewers, | East St. Louis, Ill. | Oct. 3 |
| Oct. 12. | Brick paving, | East St. Louis, Ill. | Oct. 3 |
| Oct. 14. | Use of sewage and land, | Salt Lake City. | Sept. 19 |
| Oct. 14. | Pipe sewers (15 m.), | Far Rockaway, N. Y. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 to Oct. 10. | | |
| Oct. 14. | Intake pipes, | Evansville, Ind. | Sept. 26 |
| | Advertised, Eng. News, Sept. 26 and Oct. 3. | | |
| Oct. 14. | Pump well, etc., | Evansville, Ind. | Sept. 26 |
| | Advertised, Eng. News, Sept. 26 and Oct. 3. | | |
| Oct. 14. | Removing bridge spans, | Richmond, Tex. | Oct. 3 |
| Oct. 14. | Lumber for New York and B'k'lyn Br. | | Oct. 3 |
| Oct. 14. | Grading, | Crawfordsville, Ind. | Oct. 3 |
| Oct. 14. | Reservoir, | Randolph, N. Y. | Oct. 3 |
| Oct. 14. | Paving, | Baltimore, Md. | Oct. 3 |
| Oct. 15. | Cast iron pipe, | Jacksonville, Fla. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 to Oct. 3. | | |
| Oct. 15. | Hydrants, etc., | Jacksonville, Fla. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 to Oct. 3. | | |
| Oct. 15. | Sewer pipe, | Jacksonville, Fla. | Sept. 19 |
| | Advertised, Eng. News, Sept. 19 to Oct. 3. | | |
| Oct. 15. | Artesian well, | Jacksonville, Fla. | Sept. 26 |
| Oct. 15. | Water-wks system, | Columbus Junc., Ia. | Sept. 26 |
| | Advertised, Eng. News, Sept. 26 to Oct. 10. | | |
| Oct. 15. | Water bonds, | New Painesville, Minn. | Sept. 26 |
| Oct. 15. | Cement sidewalks, | Indianapolis, Ind. | Sept. 26 |
| Oct. 15. | Naval supplies for Mare Island, Cal. | | Oct. 3 |
| Oct. 15. | Highway swing bridge, | Hamilton, Ont. | Oct. 3 |
| Oct. 15. | Roof covering, etc., | Washington, D. C. | Oct. 3 |
| Oct. 15. | Crushed limestone, | Toledo, O. | Oct. 3 |
| Oct. 15. | Fireproof room, | Cambridge, Mi. | Oct. 3 |
| Oct. 15. | Macadamizing, | Mount Vernon, N. Y. | Oct. 3 |
| Oct. 15. | Cement sidewalks, | Logansport, Ind. | Oct. 3 |
| Oct. 16. | Plans for city hall, | Somerville, Mass. | Aug. 29 |
| Oct. 16. | Water-works system, | Watertown, Wis. | Oct. 3 |
| | Advertised, Eng. News, Oct. 3. | | |
| Oct. 16. | School building, | Ridgefield, N. J. | Oct. 3 |
| Oct. 16. | Heating court house, | Sherman, Tex. | Oct. 3 |
| Oct. 17. | Wharf work, | Tompkinsville, N. Y. | Oct. 3 |
| Oct. 18. | Iron bridge, | Oswego, Kan. | Sept. 26 |
| Oct. 17. | Subway, | Boston, Mass. | Oct. |
| | Advertised, Eng. News, Oct. 3 and 10. | | |
| Oct. 18. | Cement, etc., | Detroit, Mich. | Oct. |
| | Advertised, Eng. News, Oct. 3 and 10. | | |
| Oct. 18. | Water-works system, | Theresa, N. Y. | Oct. |
| | Advertised, Eng. News, Oct. 3 and 10. | | |
| Oct. 19. | Public lighting, | Knoxville, Tenn. | Sept. 19 |
| Oct. 19. | Electric light plant, | Norwood, O. | Oct. |
| Oct. 21. | Pumping engine, | Washington, D. C. | Sept. 12 |
| | Advertised, Eng. News, Sept. 12. | | |
| Oct. 21. | Moving stone in Kentucky. | | Sept. 26 |
| Oct. 21. | Roof for pub. build'g, | Washington, D.C. | Sept. 26 |
| Oct. 21. | Paving, | Toledo, O. | Oct. |
| Oct. 21. | Macadamizing, | Waukegan, Ill. | Oct. |
| Oct. 22. | Water-wks., | near Port Townsend, Wash. | Oct. |
| Oct. 22. | Office building, | Danville, Ill. | Oct. |
| Oct. 22. | Pipe sewers (13,300 ft.), | Frankfort, Ind. | Oct. |
| Oct. 24. | State penitentiary, | Nashville, Tenn. | Oct. |
| Oct. 24. | Sewers, | Washington, D. C. | Oct. |
| | Advertised, Eng. News, Oct. 3. | | |
| Oct. 26. | Bronze tablet, | Gettysburg Military P'k. | Sept. 12 |
| | Advertised, Eng. News, Oct. 3. | | |
| Oct. 30. | Court house, | South Bend, Ind. | Sept. 26 |
| Nov. 1. | Plans school building, | Pittsburg, Pa. | Aug. |
| Nov. 1. | Plans for school building, | Pittsburg, Pa. | Sept. 26 |
| Nov. 1. | Dike work, | Philadelphia, Pa. | Oct. |
| | Advertised, Eng. News, Oct. 3 to 24. | | |
| Nov. 4. | Court house, | Morgantown, Ga. | Oct. |
| Nov. 5. | Pile bridges, | Allison, Ia. | Sept. 26 |
| Nov. 10. | Water-works system, | Honey Brook, Pa. | Oct. |
| Nov. 19. | State capitol, | Olympia, Wash. | Sept. 12 |
| | Advertised, Eng. News, Sept. 12 to Oct. 31. | | |
| Nov. 20. | Drainage canal work, | Chicago, Ill. | Sept. 26 |
| | Advertised, Eng. News, Sept. 26 to Nov. 14. | | |
| Dec. 2. | Sewers (22 miles), | Mobile, Ala. | Sept. 19 |
| | Advertised, Eng. News, Aug. 29 to Oct. 24. | | |

### RAILWAYS.

#### East of Chicago.

ALTOONA & PHILIPSBURG CONNECTING.—A press report from Altoona, Pa., states that the sheriff of Centre county will sell this railway on Oct. 2. This road is now in operation between Philipsburg, Centre county, and Ramey, Clearfield county, 13 miles. The stock consists of three engines, seven passenger cars, fifty freight cars and three baggage cars. The road was destined to be a part of the Beech Creek system when completed. Pres., S. P. Langdon, Philadelphia.

COUDERSPORT & PORT ALLEGHENY.—The extension of this railway to Ulysses is practically completed. Regular trains will commence running about Oct. 10. The extension proper is 22.5 miles in length. Thos. J. Rogers, Ch. Engr., Buffalo, N. Y.

LIMA NORTHERN.—The awarding of contracts for constructing the first 35 miles of this railway, as advertised in Engineering News, is noted under Contract Prices. W. B. Strang, Jr., 15 Wall St., New York, informs us that 35 miles more will be let as soon as profiles are ready, and that several articles on this letting were omitted because the plans were not ready.

MICHIGAN & OHIO BELT LINE.—Incorporated in Ohio Sept. 23 to build a railway from the north line of Williams county to Columbus, O.; capital stock, $10,000; incorporators, Jeremiah W. Boynton, Hiram N. Averill, Crosby G. Sweet, Guy E. Smith and Clark J. De Witt; principal office at Pioneer, O.

NEW YORK, NEW HAVEN & HARTFORD.—C. W. Blakeslee & Son, of New Haven, Conn., have been awarded the contract for constructing a spur track about a mile in length in Wallingford, to connect the factory of Wallace & Son, with the main line.—Press reports state that this company will soon meet the railroad commissioners and various city and town officials of the state, and endeavor to complete arrangements for the elimination of grade crossings in the state. There are about 30 remaining between New Haven and New York, most of them in the vicinity of Bridgeport, and it is estimated that $2,000,000 will be necessary to abolish them. The details are to be settled as soon as possible.

#### Southern.

BLOUNTSVILLE & BANGOR.—A. E. Fields, D. M. Parrish and others, of Blountsville, are said to be forming a company to build a railway from Blountsville to Bangor, on the Louisville & Nashville system.

CAROLINA.—A movement is well under way to build a 25-mile independent link of railway between Henrietta, N. C., and Spartanburg, S. C., and an election has been ordered at Spartanburg on a proposition to issue $45,000 in bonds in aid of the enterprise. Spartanburg is now the terminus of the Port Royal & West Carolina road, and if the Port Royal road is maintained separately from the Central of Georgia, this link would become an important independent line in the Piedmont section of the Carolinas, and would make a new outlet, via the Seaboard Air Line, for the products of the many cotton mills in that section. As yet the Seaboard Air Line has not become associated with the scheme, but on account of the close identification of the interests of the link, if built, and the S. A. L., it is thought probable that the S. A. L. will take hold of the matter and see that it is carried out, if there becomes any doubt of the success of the plan otherwise.

LA FOLLETTE.—Press reports state that the La Follette Coal Co., of La Follette, Tenn., has made a provisional contract with the well-known railway firm of Mallory, Cushion & Co., of Chicago, to construct a railway from Jellico via Big Creek Gap to Knoxville, 52 miles, connecting there with the Marietta & North Georgia road and at Jellico with the Louisville & Nashville. The provision referred to is that Campbell county shall vote a subscription of $75,000. Pres., H. M. Follette.

MOORE COUNTY.—We are informed that this company has decided to make an 11-mile extension to its road, and surveyors were last week put to work on the proposed route.

TENNESSEE MIDLAND.—The Jackson, Tenn., "Whig," states that the Tennessee Midland and the Paducah, Tennessee & Alabama railways are to be sold Oct. 17. After the sale it is believed there will be a consolidation of these lines with the Drawford, running east from Lebanon, Tenn., and the Tennessee Central, running to Knoxville and connecting with the Cincinnati Southern. With the gap closed between Perryville, on the Tennessee River, and Lebanon, and the 60-mile gap completed beyond Lebanon, this would be indeed a great system of railway.

### Northwest.

BLOOMINGTON & CHICAGO.—This company has been organized at Bloomington, Wis., with a capital stock of $150,000, to build a railway from Bloomington to Lancaster, 16 miles. Patrick Flynn, a railway builder, has made surveys for the road. Pres., A. C. Tubbs; Vice-Pres., Grant Ballentine; Treas., M. F. Woodhouse; Secy., A. J. Frasier.

NORTHERN PACIFIC.—Press reports from Crookston, Minn., state that the receivers of the Northern Pacific have arranged to extend the spur which connects the large Keystone farm with the Red Lake Falls branch, a distance of 12 or 15 miles, north through the towns of Tabor and Farley into Marshall county, paralleling the Great Northern's St. Vincent line. The extension will only be run a distance of 15 miles this fall. The right of way has been secured by M. C. Malone and others, of Crookston; deeds are made, and grading will be begun this week. The road will tap a rich wheat country, which is now tributary to the Great Northern, and it will haul out 300,000 bushels of wheat this year.

PEORIA & SOUTHERN.—A press report from Lacon, Ill., states as follows: Mayor Robert Fort and George Wightman, a civil engineer and railway contractor, both of Lacon, and Mr. Jobst and other Peoria gentlemen, have for the past four months quietly gone over the survey of the old Peoria & Southern R. R., and it is understood they have virtually secured the right of way between Peoria and Hennepin, on the east side of the Illinois River. The gentlemen are reticent, but rumor has it that with the completion of the road the Chicago & Alton, Illinois Central, Santa Fe, and the Northwestern roads will have an entrance to Peoria, and the Iowa Central will push on toward Chicago.

### Southwest.

ARKANSAS.—The Little Rock, Ark., "Gazette" states that Little Rock will give $100,000 to the first company completing a railway from that city to a good point westward, and that Hot Springs has offered $50,000 to the first company building a railway westward, via Hot Springs.

ATCHISON, STOCKTON & DENVER.—Incorporated in Kansas Sept. 21 to build a railway from Stockton, Rooks county, west through Rooks and Graham counties to a point on the Union Pacific, Lincoln & Colorado, between the towns of Bogue and Hill City, thence west to the state line, a distance of 165 miles in Kansas, and on to Denver; capital stock, $1,000,000; incorporators, A. J. Harwis, R. B. Drury, A. J. Felt, H. H. Bayley, of Atchison; A. H. Ellis, F. T. Burnham, F. T. Rodgers, of Beloit; E. S. Ellis and W. W. Caldwell, of Concordia; H. J. Hawl, D. J. Hanna, of Hill City; W. B. Hamo, of Stockton; J. W. Anderson, of Brewster; Robert R. Hayes, and John A. Morton, of Osborne.

CHOCTAW, OKLAHOMA & GULF.—The extension of this railway was completed last week, according to press reports. The line has been in operation for some time from Wister to Calvin, 66 miles, and from Shawnee to Fort Reno, 70 miles, and under construction between Calvin and Shawnee, 53 miles. Ch. Engr., J. F. Hinckley, South McAlester, Ind. T.

KANSAS & TEXAS COAL CO.—A press report from South McAlester, Ind. T., states that W. Bond, Chief Engineer of the company, has begun the surveys for a new railway to be built from that city to Fort Smith, Ark., about 100 miles.

NEVADA & EL DORADO SPRINGS.—Incorporated in Missouri to build a railway between Nevada, Mo., and El Dorado Springs; capital stock, $300,000; directors, W. P. Cruce, of El Dorado; Harry C. Moore, of Nevada; W. A. McPherson, of Boonville; W. B. Gibson, of Cooper county. Capt. W. A. McPherson, who is the chief projector of the road, is quoted as stating that work would be begun on the road Oct. 1 at El Dorado, and at Nevada as soon as the $15,000 bonus is raised. The Nevada subscription of $15,000 has been nearly all secured and the balance will be forthcoming. The road is said to be an independent enterprise, though it is rumored that the Missouri Pacific will make it a link in a line to Bagnall to secure a shorter St. Louis connection via Jefferson City.

### STREET AND ELECTRIC RAILWAYS.

BELLOWS FALLS, VT.—Press reports state that F. L. Houghton and Harry Lawrence, of Brattleboro, have been at Bellows Falls looking over the route to Saxton's River, with a view of building an electric road 4½ miles long to that place. The project was discussed and a charter for the road secured in 1892, but necessary capital could not be secured then, and the matter was dropped. In case it is decided to build, work will be commenced at once and the road completed this fall.

DEDHAM, MASS.—The Norfolk & Central St. Ry. Co. has been organized to build an electric railway 10 miles long from Dedham Center to West Walpole, by way of Dedham, Norwood and Walpole; capital stock, $75,000; Thos. T. Robinson and John R. Bullard, of Dedham; Francis Doane, of Norwood; A. R. Whittier, of Boston; Walter E. Geer, of Hyde Park, and Chas. E Stanwood, of Highlandville, are interested.

NEW LONDON, CONN.—Surveys and estimates have been made for an electric railway down the Thames Valley. Wm. A. Tucker and Winthrop Coffin, of Boston; John F. Perry, of Brookline; Walter Learnerd, of New London, and C. P. Cogswell and E. P. Shaw, Jr., of Norwich, are interested.

LEWISTON, N. Y.—The right of way has nearly all been secured for an electric road between this city and Youngstown, surveys for which are now being made. Pres., Lawrence D. Rumsey; Vice-Pres. and Treas., Henry C. Howard; Ch. Engr., Paul Voorhees.

FORT LEE, N. J.—John W. Ferguson, of Paterson, has been awarded the contract to build a power house and car shops at Fort Lee for the Bergen Traction Co. at $50,000, according to reports.

PITTSBURG, PA.—J. J. Houghton, of Allegheny, has been awarded the contract for constructing the Knoxville, Fair Haven & Mount Lebanon St. Ry Co.'s double-track electric railway, 5½ miles long, at $161,000, and work will be begun at once. Engrs., Patterson & Tomes and McNeil & McCoy. Pres., Henry Meuschke; Vice-Pres., Chas. W. Provost; Secy., J. L. McKee; Treas., W. W. Murray.

BALTIMORE, MD.—The South Baltimore Electric Ry. Co. has been granted permission to build its railway on the Annapolis road, in the suburbs. Geo. A. Meeter and Wm. H. Crim are interested.

HAGERSTOWN, MD.—The Hagerstown & Potomac Electric Ry. Co. has petitioned the council for a franchise for its road, which it is proposed to extend to Williamsport, Funkstown and Leitersburg, Md., and Waynesboro, Pa., estimated to cost about $100,000. E. R. Sponseller, of Harrisburg, Pa.; Geo. H. Kulp and G. M. Smith, of Shamokin, Pa., and J. I. Bitner, of Hagerstown, Md., are interested.

BRIDGEWATER, VA.—It is reported that surveys are about to be made for the proposed electric railway from Basic City to Bridgewater. G. W. Berlin, of Philadelphia, and D. G. Whitmore are interested.

NEW ORLEANS, LA.—The council will soon advertise for bids for the purchase of a 50-year franchise for the proposed extension of the Canal & Claiborne St. Ry.

CLEVELAND, O.—The county commissioners have granted a franchise to the Suburban Electric Ry. Co. for its road from Randall to Lewis Corner.——Press reports state as follows: The right of way for the Wooster & Medina Electric Ry. has been secured between Strongsville and Wooster, and work will be started on the line if traffic arrangements can be made in this city and at Wooster. The estimated cost of the road is $500,000, and the length will be 45 miles.

NEW PHILADELPHIA, O.—Bids are asked until Oct. 8 for constructing and equipping an electric railway, according to reports. E. C. Brown, County Audr.

TROY, O.—The Troy, Tippecanoe & Dayton Interurban Ry. Co. has been incorporated to build an electric road; capital stock, $25,000; incorporators, Theodore Sullivan, George S. Long, George W. Scott, J. T. Knopp, P. J. Gates, W. R. Thompson, F. M. Sterritt and H. H. Weakley

ELKHART, IND.—It is reported that at a meeting held in this city Sept. 18, between J. J. Burns, of Chicago, Pres. Indiana Electric Ry., now in operation between here and Goshen, and representatives of Crosby, White & Co., of Baltimore, a contract was awarded the latter for constructing a road 30 miles long to Milford. Arrangements have also been made for a larger power house to be erected here. After the completion of the electric line from this city to Milford, the road will be extended to Fort Wayne, Ind., by way of Wolf Lake. This will cover territory where there is no railway for 20 miles. Operations are to begin at once.

HUNTINGTON, IND.—The Huntington, Columbia City & Ligonier Electric Ry. Co. has been incorporated to build a line from Huntington to Ligonier; capital stock, $50,000; Pres., Valoroes Brown; Vice-Pres., W. F. McNaggy; Treas., Thomas R. Marshall; Secy., J. H. Ruch; Gen. Man., George Ruch. It is stated that bids for 40 miles of track and all equipments will be received this fall, and the line will be in operation next year.

INDIANAPOLIS, IND.—It is reported that the final survey of the proposed Greenwood & Indianapolis Electric Railway was made Sept. 24 by Charles S. Butts. The next step will be the presenting of a petition to the county commissioners asking a right of way. Pres., Grafton Johnson.

ANN ARBOR, MICH.—Press reports state that the purchase of the Ann Arbor & Ypsilanti motor line, at present operated by steam power, is being considered by J. R. McDonald, of Detroit, who now has an option on the road, and who is operating it for eastern capitalists. Mr. McDonald intends, in the event of securing control of the line, to equip it with electricity and extend the road. The second scheme, in which Thos. D. Kearney, of this city, is interested, is the building of an electric road, 35 miles long, to Detroit, by way of Ypsilanti, Sheldon, Denton, Wayne and Dearborn, estimated to cost $500,000.

MONROE, MICH.—The Monroe Electric R. R. Co. has been organized to build a road 15 miles long, from this city to Dundee; capital stock, $50,000; Pres. and Gen. Man., W. H. Cowles, of Monroe; Secy., F. G. Strong, of Monroe; Treas., and Elec. Engr., L. E. Watkins, of Boston; directors, E. C. Rauch, of Monroe; Geo. M. Jewett, of New York, and Geo. M. Stearns, of Chelsea, Mass.

MILWAUKEE, WIS.—The Chicago & Wisconsin Inland Lakes R. R. Co. has been incorporated to build an electric railway from Chicago, Ill., to Madison, Wis., and branch lines to the lake resorts, a total length of 185 miles; capital stock, $10,000,000; incorporators, A. E. Case, Frank Boden, S. Marcus Rothschild, A. J. Toolin and G. D. Green.

SEATTLE, WASH.—The Consolidated St. Ry. Co. has awarded the contract to Rosleaf & Wold for rebuilding the power house, which was recently destroyed by fire, at $15,000. The building will be 250 × 60 ft., and a new repair shop, 300 × 30 ft., will also be erected. The Hammond Co., of San Francisco, Cal., has been awarded the contract for 15 combination cars, with two 25-HP. motors each. Supt., S. F. Shuffleton.

BOULDER, COLO.—The Mexican Industrial Ry. Co. has been incorporated by Benjamin P. Cheney, of Boston; Stephen W. Reynolds and Walter S. Wait, of Newton, Mass.; James N. George, of Plaiston, N. H.; and Arthur P. Cushing, of Boston; capital stock, $100,000. Offices of the company will be in this city, but the object of the company is the construction of electric railways, telephone and telegraph lines from the city of Mexico.

SAN JOSE, CAL.—It is reported that P. Fletcher, of Congress Springs, proposes to build an electric railway between this place and Saratoga.

### ELECTRIC LIGHT AND POWER.

BLACKSTONE, MASS.—Bids are asked until Oct. 9 for lighting the town by electricity. Address Jeremiah Gatchell, 53 State St., Boston; Andrew Booth, Blackstone, or A. B. White, Millville, Mass.

MERCER, PA.—It is reported that the construction of an electric light plant is being discussed.

ROANOKE, VA.—W. E. Thomas, Cy. Clk., writes us that the council is considering the advisability of constructing a municipal plant, but that no steps have yet been taken towards securing plans, etc.

SANFORD, N. C.—Bids are asked by J. C. Williams for constructing an electric light plant.

ATHENS, GA.—It is stated that it is proposed to issue bonds for erecting an electric light plant. W. W. Turner, Clk. Council.

DUBLIN, GA.—B. M. Hall, of Hall Bros., Atlanta, has been engaged by the aldermen to prepare plans for an electric light and water-works plant, estimated to cost $15,000.

BIRMINGHAM, ALA.—It is reported that parties at 410 Chalifoux Bldg. want to purchase a second-hand 50, 60 or 70 K-W. multipolar generator of 500 volts.

CHARDON, O.—It is stated that the construction of an electric light plant is being considered.

LONDON, O.—The council has passed an ordinance authorizing the sale of $15,000 in bonds for an electric light plant.

NORWOOD, O.—Bids are asked by the water trustees until Oct. 19, according to reports, for constructing an electric light plant. Henry Rukhoff, Trustee.

RUSHVILLE, IND.—Press reports state as follows: The council has decided to accept the proposition of the Howe Pump & Engine Co., of Indianapolis, to construct water-works and electric light plants in this city. The proposition is to put in a water and light plant for $85,000 with a 20-year franchise. The Howe Co. is to purchase the present electric light plant of the city and run it in connection with the one it is to build.

BUCHANAN, MICH.—D. D. Kent, Village Clk., writes us that he is corresponding with parties in reference to a proposed electric power plant to operate the water-works.

TRENTON, MICH.—The council has granted to Henry P. Wickham, representing a Detroit syndicate, a franchise for electric lights and water-works.

FORREST, ILL.—We are informed that this city is to have an electric light plant.

UPPER ALTON, ILL.—Geo. C. Morgan, New York Life Bldg., Chicago, has submitted plans and specifications for an electric light and water-works plant.

ST. PAUL, MINN.—A resolution has been introduced in the board of aldermen authorizing the city clerk to advertise for bids for lighting the downtown district with arc lights.

LOS ANGELES, CAL.—It is reported that an electric light company has been organized by E. E. Peck, Station D, Los Angeles, with a capital stock of $80,000.

COTTONWOOD, IDAHO.—Samuel Dunham, of the Cotton Packing Co., proposes to add an electric plant to the establishment.

NEW COMPANIES.—Shuttleworth Electric Co., Camden, N. J.; $100,000.

Grand Falls Water Power Co., Fredericton, N. B.; Pres., James Manchester.

Atmospheric Railway & Power Co., Hughesville, Va.; $1,000,000; G. W. S. Turner, Jamesburg, General Counselor.

Electric Arc Light Co., New York, N. Y.; $100,000; Lionel Sutro, Louis B. Marks, Horace C. Skelly, New York.

Washington Illuminating Co., Washington, Ia.; $50,000; Pres., Isaac Klein; Secy. and Treas., C. W. Stephens.

Oelwein Electric Light & Power Co., Oelwein, Ia.; $50,000; J. H. Kerwin, James Burlingett, D. McNab, A. C. Stevens.

Globe Electric Co., Cleveland, O.; $25,000; to manufacture telephones and other electrical and magnetic appliances; C. E. Collins, L. W. Bradley, Donald McKenzie, T. W. Larwood, Jr.

Citizens' Electric Co., Williamsport, Pa.; $2,000; Grant Sweet, C. H. Hill, Williamsport; Ray R. Sweet, L. D. Sweet, Canton; W. H. Hill, Sunbury.

Clifton Storage & Power Co., Baltimore, Md.; $2,000; to conduct a storage business and sell steam or electricity for motive power; Edward D. Onion, Wm. C. Kirby, Wm. G. Wilson, Wm. H. Green.

Merced Falls Electric Power & Mfg. Co., San Francisco, Cal.; $1,000,000, with $60,000 paid in; R. H. Dunham, Herman Jahn, San Francisco; J. T. Fleming, Augustus Laved, Alameda, Cal.; Basil Owen, London, Eng.

American Incandescent Light Co., New York, N. Y.; $1,000, with $100 paid in; J. H. Recknagel, C. L. Recknagel, Jr., Great Neck, L. I.; De Ruyter Hollin, New York; P. K. Green, Jersey City, N. J.; H. Manshake, Brooklyn, N. Y.

Warwick Electric Mfg. Co., Cleveland, O.; $20,000; to manufacture dynamos, storage batteries, arc lights and other electrical appliances, and to construct electric light plants; P. B. Warwick, Daniel H. Ridgway, Geo. F. Ridgway, C. N. Cunningham.

### BUILDINGS.

PORTLAND, ME.—The lighthouse board is making surveys for a lighthouse on the Myrtle, off Spring Point. It is probable that bids will soon be asked, as work is expected to be begun this fall.

BOSTON, MASS.—Bids are asked by the committee of the trustees of the Medfield Insane Asylum, 708 Chamber of Commerce Bldg., until Oct. 7 for constructing three buildings for the asylum.

NEW YORK, N. Y.—George Hill and Thornton B. Turner, 44 Broadway, are preparing plans for an eight-story warehouse at West Broadway and Third St. for John B. Ireland, estimated to cost about $100,000. The ruins of the building which collapsed on this site a few months ago are to be removed at once.——John R. Thomas is preparing plans for an eight-story office building on the site of the old Clearing House, at Nassau and Pine Sts. The property was bought recently by Donald Mackay from the Clearing House Association.

NEW YORK, N. Y.—Plans have been filed by Adolf Katroff, 17 East 69th St., for a nine-story brick warehouse at 20 and 24 North Moore St., to cost $80,000; by the St. Nicholas Skating & Ice Co., 35 Wall St., for a three-story brick rink on 66th St., near Amsterdam Ave., to cost $75,000; by Charles Buck, 264 Columbus Ave., for five four-story brick dwellings on 72d St., near the Boulevard, to cost $140,000; by Robt. E. Cutting, 724 Fifth Ave., for two four-story brick dwellings at 24 and 26 East 67th St., to cost $75,000.——The Hudson Bldg. Co. has been incorporated to erect an office building at 32 and 34 Broadway and 69 and 71 New St. Title has been secured by the company from Edward Fielder for 32 Broadway, Robt. T. Wilson for 34 Broadway and 69 New St., and from Louise H. Nielson for 71 New St.

RIDGEFIELD, N. J.—Bids are asked until Oct. 16 for constructing a school building. Address W. M. Sherwood; Alexander Shaler, Pres. Bd. Education.

MARCUS HOOK, PA.—A press report from Harrisburg states that the attorney-general has approved

the lease of ground at Marcus Hook for a state quarantine station on the Delaware River, and that the governor has signed it. The auditor-general will make payments from the appropriation of $300,000 as the work on the station progresses.

PITTSBURG, PA.—J. E. Allison, Arch., Pittsburg, is furnishing plans for four new churches, as follows: Methodist Episcopal, Noblestown, Pa.; Presbyterian, Venice, Washington county, Pa.; Presbyterian, Morgantown, W. Va.; Presbyterian, Sheradan, Pa.——T. C. McKee, Arch., Pittsburg, has prepared plans for a row of 10 stone residences in the East End, Pittsburg. ——M. Lang & Sons will build a large warehouse of brick and iron on South 34th St., Pittsburg. Arch., C. L. Phillis.

CAMBRIDGE, MD.—Bids are asked until Oct. 15 for constructing a fireproof room, 24 × 18 × 12 ft., in the court house at this place. John M. Colston, Pres. County Comrs.; James M. Robertson, Clk.

WASHINGTON, D. C.—Bids are asked until Oct. 15 for constructing roof covering, skylights, etc., for the post office building at Washington. Wm. M. Aiken, Supervising Arch.

HUNTINGTON, W. VA.—Bids are asked by the county clerk until Oct. 10 for constructing a new court house, to cost about $100,000. Archs., Gunn & Curtis; James B. Stewart, Supt.

COLUMBUS, GA.—Bids are asked until Oct. 11 for putting a warm-air heating and ventilating apparatus in the post office building in this city. Wm. Martin Aiken, Supervising Arch., Washington, D. C.

MORGANTON, GA.—Bids are asked until Nov. 4 for constructing a brick court house, to cost $18,000. Archs., Andrew J. Bryan & Co., Atlanta.

WEST POINT, MISS.—The Freedman's Board of Home Missions, Presbyterian, 516 Market St., Pittsburg, has charge of the new buildings to be erected for the Mary Holmes Seminary at this place; brick and stone, three stories; estimated cost, $85,000. D. E. Sheridan, of the East End, Pittsburg, will furnish the plans.

NASHVILLE, TENN.—Bids are asked by the board of prison commissioners until Oct. 24 for constructing a new state penitentiary with 800 cells.. Arch., S. M. Patton, Richardson Bldg., Chattanooga, Tenn.; R. J. Morgan, S. R. Simpson, W. M. Nixon, Bd. Prison Comrs.

CLEVELAND, O.—It is proposed to build a 14-story office building on the site of the Williamson Block, plans for which have not yet been prepared. Address H. Clark Ford or G. E. Herrick.

DEFIANCE, O.—Bartberger & East, of Pittsburg, Pa., are receiving bids for a large stone Presbyterian church, to be erected in this city.

GREENFIELD, IND.—Bids are asked by J. H. Felt until Oct. 7 for constructing a 3½-story stone hotel, 123 × 56 ft.——The county commissioners will consult with architects on Oct. 4 and 5 in regard to plans and specifications for a court house, to cost between $100,000 and $150,000. W. J. Cleary, Cy. Engr. Greenfield and Surv. Hancock county.

DANVILLE, ILL.—Bids are asked by Kimbrough & Platt, Danville, until Oct. 22 for constructing a six-story office building. Arch., M. E. Bell, 84 Adams St., Chicago.

LYONS, ILL.—It is reported that this place is discussing the question of building a town hall, estimated to cost $20,000.

MILWAUKEE, WIS.—The board of public works will probably reject the bids received for constructing a new west side high school building and ask for new ones, as the lowest bid received was about $90,000, while the appropriation is but $80,000.

CENTERVILLE, IA.—An election is to be held Nov. 5 to vote on the question of issuing $65,000 in bonds for constructing a court house for Appanoose county.

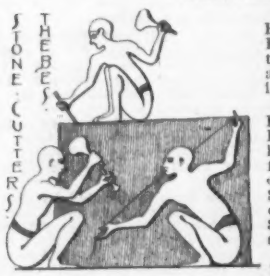
ST. HELENA, MONT.—The capitol building commission is making arrangements to receive plans for a new state capitol building estimated to cost $1,000,000.

ST. LOUIS, MO.—The Foell Architectural Co., 3347 California Ave., has prepared plans for a three-story hall and gymnasium, 150 × 118 ft., for the Southwest Turnverein, Cherokee St. and Texas Ave., to cost $200,000.

DENTON, TEX.—The county commissioners have sold $95,000 in bonds, which will be used for the construction of a new court house.

SHERMAN, TEX.—Bids are asked until Oct. 16 for heating the county court house with steam. J. H. Wood, County Judge, Sherman.

## BRIDGES.




WALTHAM, MASS.—Frank P. Johnson, Cy. Engr., writes us that the construction of a viaduct 600 ft. long is being discussed.

PITTSBURG, PA.—Edward M. Bigelow, Dir. Dept. Pub. Wks., has received the plans for a stone arch bridge over the ravine in Schenley Park, estimated to cost $75,000 to $100,000. Bids will soon be advertised for.

DETROIT, MICH.—It is stated that surveys are being made for a railway bridge from Wyandotte to the southern point of Grosse Isle. E. W. Voigt, of Detroit, and Charles Babcock, Cashier Wyandotte Savings & Commercial Bank, Wyandotte, are interested.

FRANKLIN, ME.—It is reported that Wm. D. Smith, of Bangor, has been awarded the contract for building two bridges on the Sandy River R. R., from Farmington to Rangeley, at about $50,000.

TAUNTON, MASS.—Luther Dean, Cy. Engr., writes us that he has not heard of any proposed trestle bridge over the Old Colony R. R. at Davol St., as reported in local papers and noted in our issue of last week.

JOHNSTOWN, N. Y.—W. S. Franklin, Cy. Engr., writes us that the report that this city contemplates the construction of two steel bridges is incorrect, and that no such work is projected.

RIDGEWOOD, N. J.—The following bids were received Sept. 28 by T. Y. Terbune, Chn. Com. Freeholders, for constructing a 40-ft. span Melan bridge over Saddle River:

| | |
|---|---|
| B. Gordon Bailey (informal) | $2,780 |
| Melan Arch Construction Co., New York, N. Y.. | 2,250 |
| I. H. Hathaway & Co., Philadelphia, Pa. | 2,230 |
| Woolfort & Silvey, Mount Vernon, N. Y. | 2,200 |
| A. L. Terwilleger, Ramsey, N. J.* | 1,873 |

* Awarded contract.

SCRANTON, PA.—The council has passed an ordinance authorizing the city engineer to prepare plans and specifications for constructing a new iron bridge at Eighth Ave.

ECORSE, MICH.—Bids are asked until Oct. 5 for constructing an iron or steel bridge over the River Rouge, between this city and Springwells. Francis Gillman, Highway Cmr., Ecorse; John F. E. Knoch, Highway Comr., Springwells.

DUBUQUE, IA.—The committee of the aldermen is considering the question of appropriating $25,000 for a bridge at Eagle Point. M. M. Walker, J. J. Dunn and Charles Meyer are interested.

WINONA, MINN.—Bids are asked until Oct. 10 by the board of county commissioners for constructing a 43-ft. span stone arch bridge. Address Fred H. Pickles, C. E.

WORTHINGTON, MINN.—The following bids were received Sept. 24 for constructing a steel bridge; John J. Kendlen, County Audr.:

| | |
|---|---|
| Clinton Bridge & Iron Works, Clinton, Ia. | $647 |
| J. R. Sheely & Co., Des Moines, Ia. | 675 |
| W. M. Stark & Co., Des Moines, Ia. | 629 |
| Wisconsin Bridge & Iron Co., Milwaukee, Wis. | 640 |
| Milwaukee Bridge & Iron Works, Milwaukee, Wis.. | 667 |
| Gillette-Herzog Mfg. Co., Minneapolis, Minn. | 655 |
| S. M. Hewett & Co., Minneapolis, Minn.* | 588 |

* Awarded contract.

ST. PAUL, MINN.—The citizens of St. Anthony Park are urging the city to build an iron bridge over the railway tracks at Ramsey Ave., 425 ft. long and 60 ft. wide, at an estimated cost of $60,000, or at a cost of $42,000 for a wooden structure. A. M. Woodward and D. A. Cudworth are interested.

ST. LOUIS, MO.—It is reported that Thompsoin & Gray, of St. Louis, have been awarded the contract for putting in stone abutments and piers on the St. Louis division of the Missouri, Kansas & Texas Ry. The specifications cover over 10 bridges, and the cost will be about $200,000.

LA JUNTA, COLO.—F. T. Lewis, Central Block, writes us that the commissioners of Otero county have awarded the contract for constructing a 100-ft. span combination bridge, with 80-ft. pile trestle approach over Tempas Creek, to the Bullen Bridge & Construction Co., of Pueblo, Colo., at $2,795. The foundations will be tubular iron piers 36 ins. in diameter.——The commissioners of Prowess county have awarded the contract to the Wrought Iron Bridge Co., Canton, O., for constructing a steel bridge of six spans of 125 ft. each over the Arkansas River at Lamar.

OKLAHOMA CITY, OKLA.—Bids are asked until Oct. 7 for constructing two bridges. S. H. Miller, County Clk.

RICHMOND, TEX.—Bids are asked until Oct. 14 for removing the end spans of the old iron bridge at Richmond. J. A. Ballowe, County Judge.

SHERMAN, TEX.—Bids are asked until Oct. 7 for constructing one or more bridges. J. C. Edmonds, Mayor; J. M. Wharton, Cy. Secy.

HAMILTON, ONT.—Bids are asked until Oct. 15 for constructing the superstructure for a highway swing bridge over the Burlington Channel, near Hamilton. E. F. E. Roy, Supt. Dept. Pub. Wks., Ottawa, Ont.

## SEWERAGE.

RUTLAND, VT.—Bids are asked by the street commissioners until Oct. 7 for constructing 6,500 ft. of 8 to 4-in. pipe sewers, as stated in our advertising columns. Sidney Smith, Cy. Engr.; H. B. Whittier, Cy. Clk.

BOSTON, MASS.—The following bids have been received by the superintendent of streets for constructing a sewer in Lauriat Ave.:

| | |
|---|---|
| Metropolitan Construction Co. | $20,086 |
| Davy.n & Cronin | 14,906 |
| H. P. Nawn (awarded contract). | 12,690 |
| Quimby & Ferguson | 22,051 |
| F. A. Snow | 19,524 |
| J. C. Coleman | 20,742 |
| D. E. Lynch | 21,728 |
| James Dolan | 18,516 |
| Collins & Ham | 16,294 |
| Dennis O'Connell | 14,055 |

PEABODY, MASS.—Henry Wardwell, Town Solicitor, writes us that the state board of health is to report to the next legislature on a joint system for Salem and Peabody.

STONEHAM, MASS.—W. Massey, Secy. Com., writes us that nothing will be done this year towards a system, except making a preliminary survey. Probably work will be begun next spring.

WALTHAM, MASS.—Frank P. Johnson, Cy. Engr. and Supt. Sewers, writes us that it is proposed to construct 12,000 ft. of 15 and 12-in. pipe sewers, at an estimated cost of $25,000.

NAUGATUCK, CONN.—E. C. Barnum writes us that there has only been a few preliminary surveys made as yet towards the proposed system. It is probable that no construction will be done this year. Geo. C. Ham, Borough Engr.

ALBANY, N. Y.—Bids are asked until Oct. 7 for constructing 15 to 6-in. pipe sewers in High St. Thos. J. Lanahan, Clk. Bd. Contract.

BATAVIA, N. Y.—G. W. Tomlinson writes us that the plans for a system were prepared by a local engineer, assisted by Emil Kulchling, of Rochester.

BATH-ON-THE-HUDSON, N. Y.—Bids are asked until Oct. 7 for constructing 8-in. pipe sewers in several streets. J. B. McNary, Village Clk.

DUNKIRK, N. Y.—J. K. MacDonald, Cy. Engr., writes us that plans have been prepared for 6,000 ft. of 15-in. pipe sewer.

HAVERSTRAW, N. Y.—The construction of sewers is being urged.

JAMAICA, N. Y.—Dr. Philip M. Wood, Pres. Comrs., writes us that the maps and plans for a system will be presented to the state board of health this week for its approval. Engr., John J. McLaughlin, Jamaica.

NORTH TARRYTOWN, N. Y.—Morgan Purd, Cy. Clk., writes us that plans have been prepared for sewers, but a few alterations will be made previous to advertising for bids. Engr., J. Leeland Fitzgerald. David Silver, Sewer Comr.

ROCHESTER, N. Y.—Bids are asked until Oct. 7 for constructing pipe sewers in two streets and cement sidewalks in two others. Thos. J. Neville, Clk. Executive Bd.

SANDY HILL, N. Y.—Orville Griffin writes us that a board of sewer commissioners has been appointed, and arrangements are about to be made with John Burke, Engr., of New York, for plans for a system.

RAHWAY, N. J.—Bids are asked for constructing a 700-ft. 8-in. pipe outlet sewer,to connect with the Franklin School. W. E. Clark, Cy. Engr.——It is proposed to construct 3,600 ft. of 20 and 15-in. pipe sewers to connect the state reformatory sewer system with the river. S. R. Ryno, Cy. Clk.

RED BANK, N. J.—The construction of a system is proposed, according to reports. Theodore White, Clk. Comr.

BEN AVON, PA.—We are informed that Trimble & Miller, of Pittsburg, have prepared plans for a system, but no definite action has yet been taken. Wm. J. Dunn, Ch. Com., Penn Bldg., Pittsburg.

SHARON, PA.—Bids are asked until Oct. 11 for constructing 1,770 ft. of 60 to 26-in. brick and 15,885 ft. of 30 to 8-in. pipe sewers, as stated in our advertising columns. Engr., Alexander Potter, Lewis Block, Pittsburg; Joseph Forker, Chn. Com.; F. C. Taylor, Secy. Pro Tem. Council.

STEELTON, PA.—It is stated that the construction of a system is being considered by the council.

WASHINGTON, D. C.—Bids are asked by the district commissioners until Oct. 24 for constructing sewers, as stated in our advertising columns.

SPARTANBURG, S. C.—John Elford writes us that the construction of a system is being discussed, but that no definite action will be taken until after Oct. 20, when a new council will be elected.

JACKSON, MISS.—The question of constructing a system is being considered.

NASHVILLE, TENN.—It is reported that the board of public works wants bids for constructing a sewer.

CHILLICOTHE, O.—The council has about decided to construct a system, work on which will be begun this fall.

GREENVILLE, O.—H. J. Brenneman, Cy. Clk., writes us that John P. Force, of Fostoria, O., has been engaged to prepare plans, estimates, etc., for a system, on which a vote will be taken.

FRANKFORT, IND.—Bids are asked until Oct. 22 for constructing 13,300 ft. of 10 to 6-in. pipe sewers, four flush tanks, 13 manholes, etc. J. Hammond, Cy. Engr.

VINCENNES, IND.—Jere Herskey, Cy. Engr., writes us that plans are being prepared for a system.

LANSING, MICH.—Dr. A. S. Hyatt, City Physician, is urging the construction of sewers.

CHICAGO, ILL.—Bids are asked until Oct. 8 for constructing sewers in seven streets. Wm. D. Kent, Comr. Pub. Wks.——The property owners interested in the construction of the 83d St. sewer have adopted the plans for the proposed system, which will be 16 miles long, and is estimated to cost $1,295,000. C. L. Clausen, Cy. Supt. Sewers.

EAST ST. LOUIS, ILL.—Bids are asked by the council until Oct. 12 for constructing about 7,000 ft. of 24 to 6-in. pipe sewers. L. L. Harper, Acting Cy. Engr.

LITCHFIELD, ILL.—E. F. Harper, Cy. Engr., writes us that the city had intended to construct 1,300 ft. of 66-in. brick sewer, but the matter has been postponed till next year.

NEENAH, WIS.—Bids are asked until Oct. 8 for constructing sewers. T. T. Moulton, Cy. Clk.

CEDAR RAPIDS, IA.—The aldermen have voted to advertise for bids for constructing certain sewers.

DES MOINES, IA.—Bids are asked until Oct. 9 for constructing a 12-in. pipe sewer in Ridge Road. Edward Wright and John Sherman, Bd. Pub. Wks.

DUBUQUE, IA.—Bids are asked until Oct. 5 for constructing a 12-in. pipe sewer. W. H. Knowlton, Cy. Engr.

BOULDER, COLO.—The council has decided to advertise for bids for constructing a system, according to reports.

TELLURIDE, COLO.—The construction of a system, estimated to cost about $10,000, is being considered. Harvey C. Lowry, of Denver, and George Rohwer, Courthouse, Telluride, are interested.

LAWRENCE, KAN.—Bids are asked until Oct. 7 for constructing a sewer. A. J. Honnolt, Cy. Clk.

HOUSTON, TEX.—It is reported that the council has passed a resolution calling for an election to vote on the question of issuing bonds for sewers.

FRESNO, CAL.—It is stated that surveys are being made for about 47,000 ft. of 16 to 6-in. pipe sewers. Louis Manuel, Cy. Engr.

SANTA ANA, CAL.—The question of constructing a system, at an estimated cost of $50,000, is being discussed. Dr. J. H. Garner is interested.

AMHERST, N. S.—The committee has recommended the construction of a system 25,445 ft. long, at an estimated cost of $28,500. Engrs., John M. Connolly, of Toronto, Ont., and Chas. G. Waitt, of Boston, Mass.; N. Curry, Chn. Com.

## GARBAGE DISPOSAL.

NEW BRUNSWICK, N. J.—The following bids were received Sept. 23 for the removal of garbage for one year, all the bidders being residents of this city: John Barbour, $2,385; John Dutshler, $2,400; Philip Reily, $3,120; Chas. Felton, $3,250; Fred. Felton, $3,330 John Sebolt, $3,375; J. J. McCloskey, $3,500; W. H. Pollard, $3,575; C. B. McCrellis, $3,650; Frisch & Vogel, $3,900; Burns & Kelley, $4,125; W. W. Van Doren, $4,200; John Wortman, $4,440; James D. Toole, $4,950; James Toole, $5,000; E. Hunt & Son, $5,498.

LANCASTER, PA.—It is reported that the city council has passed an ordinance submitting to the electors of the city the question of increasing the city debt $100,000 for the establishment of a garbage crematory.

PEORIA, ILL.—A press report states the city council has voted to establish a garbage crematory, and a special meeting of the committee has been held to consider a proposition from Dr. B. C. Price and J. B. Rose, of the Lincoln National Bank, of Chicago, who propose to erect a Dixon 100-ton garbage crematory for $16,000.

## WATER-WORKS.

SOMERSWORTH, N. H.—The committee on water supply has awarded the following contracts: Great Falls Granite Co., foundations for the stand-pipe; the Eddy Valve Co., Waterford, N. Y., valves; Joseph Bruno, East Boston, Mass., pipelaying, at $10,041; Holyoke Hydrant & Iron Works, Holyoke, Mass., hydrants. The action of the council to reject all the bids for pipelaying, as noted last week, was rescinded.

WATERBURY, VT.—Joel Foster, of Montpelier, Vt., has been engaged to prepare plans for the proposed works. W. P. Dillingham, Chn. Com.

BOSTON, MASS.—The first $5,000,000 of bonds of the metropolitan water loan has been sold to E. H. Gay & Co., of Boston, at 110.67, being about a 3.05% basis. These bonds will bear 3½% interest, and are a portion of the $27,000,000 loan, recently authorized.

GLOUCESTER, MASS.—At an election Sept. 24 the citizens voted, 1,073 to 116, to buy the works under the terms of the act of 1895.

AKRON, N. Y.—J. F. Witmer, of Buffalo, has reported that the proposed works would not cost over $28,000. J. E. Paxon, P. P. Hart and H. H. Newton were appointed a committee to request that a special election be held to vote on the question of construction.

BUFFALO, N. Y.—Bids are asked until Oct. 8 for constructing a new conduit and well for the new 30,000,000-gallon pumping engine, etc. R. G. Parsons, Secy. Dept. Pub. Wks.

DELHI, N. Y.—Bids are asked until Oct. 12 for constructing works, according to reports. H. S. Graham, Pres. Comrs.

NIAGARA FALLS, N. Y.—The contracts for the proposed extensions have been awarded as follows: Makin & Cookman, of Niagara Falls, for pipelaying; Addyston Pipe & Steel Co., for pipe, and Oliver & Co., for hydrants. The itemized bids for pipelaying were published last week.

ONEIDA, N. Y.—The Stanwix Engineering Co., of Rome, has been engaged to prepare plans and specifications for a 75,000,000-gallon reservoir.

PHILADELPHIA, N. Y.—The residents of this village have voted for works by a majority of 96.

RANDOLPH, N. Y.—Bids are asked until Oct. 14 for constructing a reservoir, the estimated quantities including 300 cu. yds. of rubble masonry, 1,000 cu. yds. of embankment, 1,600 cu. yds. of puddle embankment and 360 sq. yds. of riprap. W. L. Rathbone, Secy. Comrs.; C. C. Sheldon, W. W. Supt.

SANDY HILL, N. Y.—The contract for relaying certain water mains has been awarded to John Marsden, of Utica, at $5,900.

SAUGERTIES, N. Y.—It is reported that plans have been completed for works at this place.

THERESA, N. Y.—Bids are asked until Oct. 18 for the construction of works, as stated in our advertising columns. Hinds & Bond, Engrs., Watertown; Henry P. Cheesman, Secy. Comrs.

WEST CARTHAGE, N. Y.—The contract for constructing works is reported to have been awarded to A. F. Nims, of Philadelphia, N. Y., at $11,000.

WILLIAMSVILLE, N. Y.—The contract for constructing works has been awarded to W. B. Wilson, of Buffalo, at $17,683. The valves and boxes will be furnished by the Rensselaer Valve Mfg. Co., the hydrants by the Ludlow Valve Co., the pump by the Snow Steam Pump Co., the stand-pipe by Tippett & Wood, and the pipe by the Addyston Pipe & Steel Co.

DECKERTOWN, N. J.—The council is reported to have again voted to secure estimates for works. F. B. Whittle, Cy. Clk.

ALLEGHENY, PA.—The contract for six boilers has been awarded to the Edgemoor Iron Co., at $45,200. The bids were published in our issue of Sept. 12.

HANOVER, PA.—A new water company has been organized, with a capital stock of $60,000. Pres., J. S. Young; Secy., C. E. Moul.

HONEY BROOK, PA.—Bids are asked until Nov. 10, according to reports, for constructing gravity works. A. M. Anderson, Borough Secy.

KENNETT SQUARE, PA.—The council has awarded the contract for another stand-pipe to the Coatesville Boiler Works, at $2,819.

LEBANON, PA.—Geo. W. Hayes, Cy. Engr., has been requested by the councils to make an investigation into the feasibility and probable cost of a large storage reservoir north of the city; the same to connect with the South Mountain reservoirs, the present water supply. We are informed that the question of constructing larger mains throughout the city is also being agitated.

PHILADELPHIA, PA.—Bids are asked until Oct. 8 for the construction of a concrete wall at the Queen Lane reservoir. Thos. M. Thompson, Dir. Pub. Wks.

WEST CHESTER, PA.—It is reported that efforts are being made to secure a water supply from the Brandywine in order to guard against any future scarcity of water.

WILKES BARRE, PA.—The council has directed the city attorney to take action to revoke the charter of the Crystal Spring Co., if it does not secure a sufficient supply of good water for its patrons within three months.

WASHINGTON, D. C.—Bids are asked until Oct. 22 for a water supply station, complete, for the U. S. Quarantine station, Diamond Point, near Port Townsend, Wash. W. M. Aiken, Supervising Arch., Treasury Dept.

CUMBERLAND, W. VA.—The Western Filter Co. has submitted a proposition for the construction of a filter plant to cost less than $20,000.

DUBLIN, GA.—A press report states that D. M. Hall, of Hall Bros., of Atlanta, has been engaged to prepare plans for a water-works and electric light plant, to cost about $15,000.

EUFAULA, ALA.—The council has voted to annul its contract with the water company and to construct municipal works as soon as possible. Address the mayor.

FRANKLIN, KY.—It is stated that owing to a legal technicality a new election will be required in order to construct municipal works, and that there is talk of granting a franchise.

EAST CLEVELAND, O.—Chas. L. Parmelee, of Toledo, has reported that a sufficient water supply can be obtained in the hills south of the village, and that works would cost about $77,000. The committee is now securing options on the land for sinking test wells.

HIRAM, O.—Edwin L. Hall writes us that plans have been made for works estimated to cost $8,000, but that no election has yet been held to vote on the question; the water supply will be from springs, and will probably be pumped to a reservoir.

MANSFIELD, O.—The water-works trustees are reported as about to take steps to increase the water supply. It is stated that about $8,000 is now on hand and $20,000 more in sight for this work.

SABINA, O.—An election will soon be held to vote on the question of constructing works estimated to cost about $15,000, according to reports.

TIPPECANOE CITY, O.—Sanders & Porter, of Louisville, Ky., have been engaged to make surveys and design a system of works for this place.

MONTICELLO, IND.—B. Van Voorst, Clk., writes us that Mansfield & Allen, of Indianapolis, are the contractors for the new works; H. R. Worthington furnishes the pumps; the Addyston Pipe & Steel Co. the pipe; the Ludlow Valve Co. the valves and hydrants, and the Chicago Iron & Bridge Co. the stand-pipe; W. S. Shiels, of Chicago, is the engineer.

ROYAL CENTER, IND.—Bids are asked until Oct. 8 for constructing works estimated to cost about $6,000. J. C. Wentworth, Clk.

RUSHVILLE, IND.—The council is reported to have accepted the proposition of the Howe Pump & Engine Co., of Indianapolis, to construct works and an electric light plant, to cost about $85,000.

CORUNNA, MICH.—This city has voted against issuing $20,000 in bonds for works, the proposition being defeated by seven votes.

CROSWELL, MICH.—The Michigan Pipe Co., of Bay City, has been awarded the contract for constructing works at this place. Improved Wyckoff pipe made by this firm will be used. The plant will include a pump house, boilers, pumping machinery, elevated tank, etc.

DETROIT, MICH.—Local papers state that 17 one-acre lots have been sold in the vicinity of the Log Cabin farm at $1,500 each, and that William H. Ashwell has prepared plans for an electric light and water-works plant at that place, which will soon be constructed; the water supply will be pumped from artesian wells to a reservoir.

MOUNT CLEMENS, MICH.—The water commissioners are selecting a site on Lake St. Clair for the new works. H. H. Orbits, Ch. Engr.; W. S. Parker, of Pontiac, Consult. Engr.; Spencer Dolby, Clk.

OLIVET, MICH.—The council has appointed H. C. Green, K. D. Keyes and Mayor Hickok a committee to investigate the question of works.

ASSUMPTION, ILL.—At a special election Sept. 26 the citizens voted to issue $15,000 in bonds for works.

CLINTON, ILL.—J. E. Moffett, Supt., writes us that a new reservoir is being constructed to cost about $6,000, the work being done by day labor.

FRANKLIN GROVE, ILL.—This village is reported as considering plans for constructing works.

LINCOLN, ILL.—The special committee appointed by the mayor to investigate the feasibility of constructing municipal works has reported that the city has a legal right to build such a plant. It is thought that with 22 miles of mains a system would cost about $75,000.

ODELL, ILL.—We are informed that this village is boring for water with the intention of constructing works.

UPPER ALTON, ILL.—Geo. C. Morgan, of Chicago, has prepared plans and specifications for the proposed water-works and electric light plant.

DARLINGTON, WIS.—A press report states that $4,000 has been appropriated for extensions.

OCONOMOWOC, WIS.—The city clerk writes us that the water-works proposition was defeated by a vote of 4 to 1 at a special election Sept. 14, and that the question will probably not be revived until the spring election of 1896.

PARDEEVILLE, WIS.—John E. Price, Village Clk., writes us that the question of water-works is being agitated, but that the village board has not taken any action as yet.

SUPERIOR, WIS.—The council has instructed the city attorney to take steps to revoke the franchise of the Superior Water, Light & Power Co., in so far as it is the successor to the Superior Water-Works Co.

WATERTOWN, WIS.—Bids are asked until Oct. 16 for constructing works estimated to cost about $100,000, as described in our advertising columns. Engr., Geo. C. Morgan.——The Watertown Water-Works Co. was incorporated Sept. 25 with a capital stock of $100,000, by Wm. F. Voss, G. May, Fred Kusel and others.

DULUTH, MINN.—At the special election last week the citizens voted, 4,210 to 438, to issue bonds for works; vote on purchasing, 1,556 yes and 2,067 no; on buying, 3,237 yes and 1,077 no.

GROVE CITY, MINN.—Bids are asked until Oct. 9 for constructing works. J. N. Gayner, Village Recdr.

FARGO, N. DAK.—A special election will be held Oct. 15 to vote on an issue of $30,000 in bonds for water and sewer extensions. It is probable that a filter plant will be put in.

ELMWOOD, NEB.—The village clerk writes us that an election was to be held Oct. 2 for the citizens to vote on an issue of $3,000 in bonds for constructing works. The proposed plant includes a 30,000-gallon tank on a 50-ft. steel tower, a steam pump and 2,400 ft. of 4 and 6-in. pipe. Engr., A. M. Munn, Cy. Engr., Nebraska City.

CASPER, WYO.—The contract for works is reported to have been awarded to Chas. E. McGarvey, of Cheyenne, at about $40,000. The plant is to be completed this fall if possible.

BUTTE, MONT.—F. W. Blackford, Cy. Engr., writes us that the only bid received for furnishing water to the city was that of the Butte City Water Co., at $20,000 a year for 250 hydrants for fire protection for a 10-year contract; rates to consumers to be the same as heretofore; water for sprinkling carts, $2.25 per cart per day.

EDGERTON, MO.—It is reported that the citizens of this place want water-works.

GRANT CITY, MO.—A. C. Davidson, Cy. Clk., writes us that no engineer has yet been engaged to prepare plans for the proposed works and no definite action has yet been taken, except to vote $4,000 in bonds. Population, 1,000. Address the Mayor.

KIRKWOOD, MO.—The Meramec Highlands Co. has been granted a 30-year franchise. The work will include a stand-pipe 100 ft. high.

WEST PLAINS, MO.—It is reported that a water company is being formed, with a capital stock of $20,000.

BELTON, TEX.—Bids are asked until Oct. 9 for constructing works. C. J. Glover, Chn. Com.; Sam Sparks, Jr., Cy. Secy.

BOWIE, TEX.—We are informed that the works at this place are nearly completed.

GAINESVILLE, TEX.—Hunter & Booso, of Dallas, have been awarded a contract to put in a 500,000-gallon pump and a 23,000-gallon tank at the artesian well, at a cost of $2,500.

COLORADO SPRINGS, COLO.—Ord & Swoope, of Colorado Springs, have been awarded the contract for completing reservoirs 7 and 8 at $15,140 and $23,573, respectively. The itemized bids will probably be published next week. Chas. E. Smith, Cy. Clk.

ROCKY FORD, COLO.—We are informed that two artesian wells have been sunk at this place securing a flow of 68 and 180 gallons per minute, respectively, and that several more wells are in contemplation.

NEVADA CITY, CAL.—A special election will be held Oct. 28 to vote on an issue of $60,000 in bonds for works. It is stated that the present works are owned by New York parties and that the rates are excessive.

SANTA BARBARA, CAL.—The Santa Barbara Water Co. has had surveys made for a dam at Juncal for bringing the waters of the Santa Ynez to this city through a 12-mile aqueduct. The proposed work is to be commenced as soon as possible and will require 6,000 lin. ft. of rock excavation, according to local papers.

RAT PORTAGE, ONT.—Wm. Kennedy, Jr., has submitted plans for works estimated to cost $45,000.

## IRRIGATION.

SEYMOUR, TEX.—It is reported that surveys are to be made at once for an irrigation system in Baylor and conecting counties, estimated to cost $500,000 to $750,000. M. Morgan Jones and M. Lasker are interested.

NEW COMPANIES.—Wyoming Irrigation & Land Co., Cheyenne, Wyo.; $1,000,000; the company will improve a tract of Union Pacific land in Sweetwater county, under the Carey act; William Mirville, Louis Kunz, Thomas Knight, Roland Hughes, C. E. Cook, of Cheyenne; Henry D. Barte, of Kansas City; E. R. Bowman, of Leavenworth, Kan.

Washington & Idaho Irrigation Co., Spokane, Wash.; $250,000; R. E. Clark, C. W. Clark, H. M. Mosely, G. S. Palmer.

The Lolita Land & Irrigation Co., La Junta, Colo.; $50,000; to build reservoirs and reclaim land in the Horse Creek Valley; F. T. Webber, F. A. Sabin, C. Bomgardner, John O'Neil, of La Junta.

## STREETS AND ROADS.

BOSTON, MASS.—Bids are asked until Oct. 4 for 3,920 sq. yds. of granite block paving in Columbus Ave. Henry B. Wood, Acting Supt. Sts.

BROOKLYN, CONN.—We are informed that the following bids were received Sept. 25 for grading and macadamizing 2,000 lin. ft., as per specifications: Frank A. Prince, Selectman, Danielson; Robt. A. Woodbury & Co., Central Falls, R. I., $1.85 (awarded contract); John A. Doolittle & Co., 179 Church St., New Haven, Conn., $1.95 per lin. ft. for first 1,000 ft., and $1.80 per lin. ft. for second 1,000 ft.

GLASTONBURY, CONN.—The selectmen have advertised for bids for constructing a macadam road.

NEW MILFORD, CONN.—Bids are asked by the selectmen until Oct. 10 for macadamizing 5,000 lin. ft. of road, as stated in our advertising columns. F. E. Starr, Selectman, New Milford.

OLD SAYBROOK, CONN.—Bids are asked until Oct. 10 for constructing a macadam road. H. I. Clark, Selectman.

SOUTHINGTON, CONN.—Bids are asked by the selectmen until Oct. 9 for macadamizing Main St. W. S. Plumb, Selectman.

ALBANY, N. Y.—Bids are asked until Oct. 7 for paving three streets with granite blocks; six sureties of $5,000 to $5,000 each. Thos. J. Lanahan, Clk. Bd.

BROOKLYN, N. Y.—Bids are asked until Oct. 9 for paving the west driveway of the Ocean Parkway; bond, $25,000. Frank Squier, Comr. Dept. Parks.——Bids are asked until Oct. 9 for flagging portions of sidewalks in about 50 streets. Alfred T. White, Comr. Cy. Wks.——It is estimated by N. P. Lewis, Engr. Brooklyn Local Improvements, that the total cost of the proposed Eastern Parkway improvements will be $350,000.

DEPEW, N. Y.—Bids are asked until Oct. 9 for macadamizing and curbing Transit road, as stated in our advertising columns. John Graney, Chn. Com.

MOUNT VERNON, N. Y.—Bids are asked until Oct. 15 for macadamizing two streets. Elias G. Pease, Cy. Clk.

NEW YORK, N. Y.—Bids are asked by the department of public parks until Oct. 9 for about 60,000 sq. yds. of telford paving; about 160,000 sq. ft. of asphalt and rock asphalt paving, 12,000 lbs. stoneware pipe, etc.

JERSEY CITY, N. J.—Bids are asked until Oct. 8 for 1,900 sq. yds. of brick paving in the grounds of school No. 15. John C. Kaiser, Chn. Com. Pub. Bldgs.

BALTIMORE, MD.—Bids are asked until Oct. 14 for paving Riggs Ave. Janon Fisher, Cy. Comr.

RALEIGH, N. C.—It is stated that an election is to be held in November to vote on the question of issuing $50,000 in bonds for street improvements.

AVONDALE, O.—Bids are asked until Oct. 12 for constructing cement sidewalks in six streets. W. Ellwood Wynne, Corporation Clk.

CINCINNATI, O.—Bids are asked by the board of administration until Oct. 4 for paving Long Alley with brick; until Oct. 5 for paving several streets with granite blocks, and until Oct. 18 for paving Carrie St. with brick. Pres., Aug. Herrmann.

COLUMBUS, O.—Bids are asked until Oct. 9 for macadamizing Hoover Ave. James A. Fanning, Clk. Bd. Pub. Wks.

SANDUSKY, O.—Bids are asked until Oct. 12 for paving two streets with brick. A. W. Miller, Cy. Clk.

TOLEDO, O.—Bids are asked until Oct. 15 for furnishing 11,500 cords of crushed limestone. Chas. H. Jones, County Audr.—Bids are asked until Oct. 21 for paving South St. Lem. P. Harris, Cy. Clk.

CRAWFORDSVILLE, IND.—Bids are asked until Oct. 14 for grading certain streets. Jas. M. Waugh, Cy. Engr.

GOSHEN, IND.—Bids are asked until Oct. 7 for paving certain alleys with cobblestones, and for constructing sidewalks in 15 streets. Luther Swinehart, Cy. Engr.

LOGANSPORT, IND.—Bids are asked until Oct. 15 for constructing cement sidewalks. James B. Winters, Cy. Clk.

MILTON, IND.—Bids are asked by the town authorities until Oct. 10 for constructing several thousand square yards of cement sidewalks.

EAST ST. LOUIS, ILL.—Bids are asked until Oct. 12 for 10,000 sq. yds. of brick paving, 4,800 ft. of limestone paving, etc. L. L. Harper, Acting Cy. Engr.

LITCHFIELD, ILL.—E. F. Harper, Cy. Engr., writes us that the city had intended to construct about 4,000 sq. yds. of brick paving, but it has been deferred until next year.

PEORIA, ILL.—J. R. Conway, Cy. Clk., writes us that all contracts have been awarded for the paving to be done this year. The council will probably pass ordinances this winter for paving a number of streets, but no contracts will be let until late this winter or early spring.

WAUKEGAN, ILL.—Bids are asked until Oct. 21 for 41,000 sq. yds. of macadam paving, 14,000 cu. yds. of earth excavation, 20,000 lin. ft. of stone curbing, etc. Robt. B. Connolly, Cy. Clk.

DUBUQUE, IA.—Bids are asked until Oct. 5 for 3,500 sq. yds. of macadam paving, etc. T. J. Cooney, Cy. Recdr.

DULUTH, MINN.—Bids are asked until Oct. 7 for improving certain streets. R. Murchison, Clk. Pub. Wks.

SAN DIEGO, CAL.—It is stated that the city will spend $65,000 in improving streets.

STOCKTON, CAL.—The council is considering the question of macadamizing 10 miles of road, at an estimated cost of $50,000.

## MISCELLANEOUS CONTRACTS AND SUPPLIES.

DOCKS.—Lansingburg, N. Y.—Bids are asked for rebuilding docks at foot of 14th, 15th, 17th and 18th Sts. C. E. Hicks, Village Engr.

FIRE HOSE.—Boston, Mass.—Bids are asked until Oct. 10 for furnishing the fire department 5,000 ft. of 2½-in. fire hose. H. S. Russell, Comr.

LUMBER.—Brooklyn, N. Y.—Bids are asked until Oct. 14 for furnishing about 400,000 ft. of lumber for the Brooklyn Bridge. C. C. Martin, Ch. Engr.

ORE CARS.—Duluth, Minn.—The Duluth, Missabe & Northern Ry. Co. will have plans and specifications ready April 1, according to local papers, for 200 new ore cars.

NAVAL SUPPLIES.—Mare Island, Cal.—Bids are asked until Oct. 15 for furnishing paints, varnish, turpentine, etc. Address Edwin Stewart, Paymaster-General U. S. N., Washington, D. C.

WHARF WORK.—Tompkinsville, N. Y.—Bids are asked until Oct. 17 for erecting ironwork, etc., for South Face Wharf; also for removing old South Wharf. Lieut. Wm. E. Craighill, U. S. Engr. Office.

PINE LUMBER, ETC.—Port Royal, S. C.—Bids are asked until Oct. 8 for furnishing yellow pine lumber, drift bolts, and screw bolts. Address Edwin Stewart, Paymaster General, U. S. N., Washington, D. C.

DIKE WORK.—Philadelphia, Pa.—Bids are asked until Nov. 1 for constructing brush and stone dike and repairing stone dike, as stated in our advertising columns. Maj. C. W. Raymond, U. S. Engr. Office.

BULKHEAD WALL.—Brooklyn, N. Y.—Bids are asked until Oct. 10 for building a bulkhead wall, as described in our advertising columns. W. E. Belknap, Engr. Wallabout Improvement; Alfred T. White, Comr. Cy. Wks.

LEVEES.—Santa Ana, Cal.—The county clerk was instructed Sept. 25 to advertise for bids for building levees for the protection of the Olive bridge. Plans can be seen in the clerk's office; contractor to furnish $1,000 bonds.

SUBWAY.—Boston, Mass.—Bids are asked by the Boston Transit Commission until Oct. 17 for building section 3 of the subway (Park St. station), as stated in our advertising columns. B. Leighton Beal, Secy.; Howard A. Carson, Ch. Engr.

PIER WORK.—New York, N. Y.—Bids are asked by the dock department until Oct. 10 for repairing pier and approach at foot of W. 34th St.; for removing portion of Pier (new) 43, the shed and other structures and rebuilding pier; also for furnishing sawed yellow pine timber.

CEMENT, ETC.—Detroit, Mich.—Bids are asked until Oct. 18 for furnishing 1,000 bbls. of Portland cement, and for well gratings and snubbing buttons for the 800-ft. lock, St. Mary's Falls Canal, Mich., as stated in our advertising columns. Col. O. M. Poe, U. S. Engr. Office.

PIER WORK.—Philadelphia, Pa.—It is reported that the Port Wardens' committee on the improvement of the Delaware River wharves has acted favorably on the application of the Franklin Sugar Refining Co. to extend a pier to the new line. The pier will be 540 × 75 ft. This will entirely eliminate piers 28 and 29.

DOCK.—Duluth, Minn.—Nearly all the contracts for materials for the new Duluth, Missabe & Northern ore dock have been awarded. The coast timber, consisting of 1,700,000 ft. of Washington fir, has been let to Prescott Van Ess & Co., of Windlock, Wash. The contract for native timber will be let to Duluth parties, but the contract has not yet been closed. The hardware contract has been divided between the Tudor Iron Works, of St. Louis, and the Marshall-Wells Hardware Co., of Duluth, the greater part going to the former. The contract for furnishing the piling was let to Jacob Zimmerman, of Duluth. The piling is to come from the Missabe road, between Wolf and Pineland junctions. The construction is to be done by day labor.

## CONTRACT PRICES.

RAILWAY.—Lima, O.—W. B. Strang, Jr., & Co., 15 Wall St., New York, have awarded the following contracts for constructing the first 35 miles of the Lima Northern Ry., as advertised in Engineering News: W. W. Hegeman & Co., New York, tracklaying, at $10 a mile, and ballasting, at 31 cts. a cu. yd.; Bailey & Adams, Waverly, O., ties, at 36 cts.; Robert Russell, Boston, Mass., grading 6 miles, at 13 cts. per cu. yd.; John J. Strang, Boston, Mass., grading 7 miles, at 13 cts.; Kelley & Brown, Waverly, O., grading 10 miles, at 13 cts.; Wm. Johnson, St. Louis, Mo., grading 5 miles, at 13 cts.; John Welsh, St. Louis, Mo., grading 7 miles, at 13 cts.

SEWERS.—Altoona, Pa.—The contract for an intercepting sewer 15,200 ft. in length has been awarded to Campbell & Dennis. Harvey Linton, Cy. Engr., has sent us the following statement of the bids received, the amounts being based upon an estimate of the quantities in the principal items, and not upon a full and complete estimate; W. L. Shellenberger, Chn. Com.:

Bids Received at Altoona, Pa., Sept. 14 for Constructing an Intercepting Sewer.

| Quantities. | Campbell & Dennis, Joliet, Ill. | D. F. O'Rorke, Altoona, Pa. | Penny-Myers Const'n Co., St. Louis. | Wm. H. Herr, Altoona, Pa. | Stahl & Read, Altoona, Pa. | Bowman Bros., McKeesport, Pa. | Bennett & Talbot, Greensburg, Pa. | Jutte & Foley, Pittsburg, Pa. |
|---|---|---|---|---|---|---|---|---|
| 6,116 lin. ft. of earth excav. & refilling in trench containing 8,492 cu. yds. for 27-in. pipe sewer, per lin. ft. | $0.20 | $0.99½ | $0 80 | $1.10 | $0.76 | $0.50 | $1.27 | $0.77 |
| 3,164 lin. ft. of earth excav. & refilling in trench containing 4,703 cu. yds. for 30-in. pipe sewer, per lin. ft. | .25 | .99½ | .85 | 1.10 | .73 | .50 | 1.25 | 1.20 |
| 5,900 lin. ft. earth excav. & refilling in trench containing 10,875 cu. yds. for brick sewer 31¾ × 48 ins., per lin. ft. | .60 | .99½ | 1.00 | 1.10 | .74 | .60 | 1.19 | 1.40 |
| 6,116 lin. ft. of 27-in. vitrified salt-glazed pipe sewer, per linear foot of sewer | 2.00 | 2.04 | 2.00 | 2.10 | 2.34 | 2.40 | 2.45 | 2.50 |
| 3,164 lin. ft. of 30-in. vitrified salt-glazed pipe sewer, per linear foot of sewer | 2.50 | 2.34 | 2.35 | 2.40 | 2.59 | 2.70 | 2.75 | 2.90 |
| 5,900 lin. ft. of oval brick sewer 2 ft. 7¾ ins. × 4 ft., per linear foot of sewer | 1.50 | 1.59 | 1.75 | 1.65 | 2.29 | 2.40 | 1.99 | 2.54 |
| 19 manholes on 27 & 30-in. pipe sewer, per manhole compl. | 25.00 | 24.00 | 35.00 | 29.00 | 35.00 | 20.00 | 33.00 | 35.00 |
| 12 manholes on brick sewer, per manhole complete | 25.00 | 23.00 | 33.00 | 19.00 | 35.00 | 25.00 | 31.50 | 35.00 |
| Masonry, etc., for intake complete | 200.00 | 200.00 | 295.00 | 150.00 | 198.50 | 100.00 | 310.00 | 275.00 |
| Rubble masonry in outfall and elsewhere, per cu. yd. (estimated at 40 cu. yds.) | 6.00 | 4.00 | 6.00 | 3.50 | 4.50 | 5.50 | 5.00 | 6.25 |
| Oak and pine lumber, per M. ft. | 20.00 | 23.00 | 23.00 | 22.00 | 24.00 | 20.00 | 25.00 | 24.00 |
| Concrete masonry, per cu. yd. (estm. at 500 cu. yds.) | 5.00 | 6.00 | 5.85 | 5.00 | 5.65 | 5.00 | 7.00 | 5.50 |
| Rock excav. (12,000 cu. yds.), per cu. yd. | 2.00 | 1.25 | 2.95 | 1.25 | 1.00 | 5.50 | 2.25 | 1.25 |
| Totals | $42,061 | $51,568 | $53,146 | $53,479 | $53,898 | $57,061 | $63,635 | $63,788 |
| One-twentieth (1-20) or proportion of earth displaced by rock in trench to be deducted from estimate | 634 | 755 | 674 | 834 | 566 | 469 | 937 | 839 |
| Corrected totals | $41,428 | $50,812 | $52,471 | $52,635 | $53,332 | $56,652 | $62,697 | $62,949 |

ROCK EXCAVATION.—Salt Lake City, Utah.—The Mount Nebo Irrigation Co. has awarded the contract for excavation for the wasteway of its reservoir to M. H. Hennessy, of Salt Lake City. The estimated amount of work is 1,875 cu. yds. of solid rock, and the contract price is 75 cts. per cu. yd. This wasteway is to be 25 ft. wide at the bottom, and about 300 ft. long, with a maximum cut of 20 to 25 ft.

MACADAMIZING.—Norwich, Conn.—C. E. Chandler, Engr., received the following bids Sept. 16 for macadamizing a road in this town, the stone for the bottom course to be native rock, and that for the upper course and screenings to be traprock:

| Quantities. | R. A. Woodbury & Co., Central Falls, R. I. | H. L. M. Ladd, Norwich, Conn. | Stone Road Construction Co., Bridgeport, Conn. |
|---|---|---|---|
| 7 ins. macadam...3,000 sq. yds. | $1.08 | $0.90 | $1.31 |
| Hardening ..... 750 " " | .20 | .40 | .45 |
| Gutters ..... 70 " " | .35 | .50 | .55 |
| Total ..... | $3,414 | $3,035 | $4,306 |

HIGHWAYS.—New Haven, Conn.—Albert B. Hill, Consult. Engr., New Haven, has sent us the following statements of bids received for constructing roads, the prices being per lin. ft.:

Hamden, Conn., bids opened Sept. 17, road 20 ft. wide.—A. Brazos & Sons, 5 Broadway, New Haven (awarded contract), 59¾ cts. for 5-in. pavement on old foundation, and 97 cts. for new 8-in. pavement; C. W. Blakeslee & Sons, 374 George St., New Haven, $1.13 and $1.44, respectively; J. A. Doolittle & Co., New Haven, $1.15 and $1.75.

Fairfield, Conn., bids opened Sept. 19.—B. F. Buckley, Westport, Conn. (awarded contract), $1.25 for 6-in. pavement 16 ft. wide, and $1.56 for same 20 ft. wide; the B. D. Pierce Co., Bridgeport, Conn., $1.57 and $1.77, respectively; J. A. Doolittle, $2.50 and $2.75.

North Branford, Conn., bids opened Sept. 18, road 16 ft. wide.—Samuel D. Maltby & Co., Northford, Conn. (awarded contract), 55 cts. for 4-in. pavement and 95 cts. for 8-in. pavement (bid on Northford section only); Dwight M. Foote, Northford, Conn., $1.55 for 8-in. pavement (North Branford section only); J. A. Doolittle & Co., $1.50 for 4-in. pavement, $2.50 for 8-in. and $2.75 for 12-in. pavement (both sections).

Guilford, Conn., bids opened Sept. 14 and all rejected, road 22 ft. wide.—C. W. Blakeslee & Co., $1.35 for 6-in. pavement, $1.95 for 10-in. pavement, and 15 cts. for cobble gutter 3 ft. wide; A. Brazos & Sons, $1.84, $2.13 and 12½ cts., respectively; J. A. Doolittle & Co., $3.25, $3.75 and 15 cts.

Madison, Conn., bids opened Sept. 21.—S. A. Scranton, Madison, Conn., $1.47 for 8-in. pavement 18 ft. wide; J. A. Doolittle & Co., $2.75.

SEWERS.—Boone, Ia.—R. M. Mitchell, Cy. Engr., writes us that the contract for constructing sewers, for which bids were opened Sept. 18, has been awarded to J. L. Black & Co., of Omaha, Neb., at $2,210, the bids being as follows:

| Bidder. | 18-in. pipe, 880 ft. | 24-in. pipe, 1,000 ft. | Manholes, 3. | Rubble masonry, 13 cu. yds. | Stone paving, 15 sq. yds. | Total. |
|---|---|---|---|---|---|---|
| J. L. Black & Co. | $0.70 | $1.56 | $48 | $5.50 | $2.50 | $2,210 |
| C. A. Olson[1] | .77 | 1.90 | 31 | 3.00 | 2.25 | 2,553 |
| W. H. Wright[2] | 1.10 | 1.72 | 34 | 7.00 | 1.50 | 2,573 |
| Kennedy & McCann[3] | 1.25 | 1.70 | 30 | 3.00 | .50 | 2,561 |
| John Hurley & Co.[4] | .93 | 1.84 | 40 | 4.00 | 2.50 | 2,581 |
| Geo. J. Barr[5] | 1.10 | 1.80 | 35 | 10.00 | 1.50 | 2,586 |
| John McGowan[3] | 1.40 | 2.00 | 50 | 7.50 | 5.00 | 3,100 |
| L. F. Fehlrisen[2] | 1.25 | 2.10 | 60 | 9.00 | 3.75 | 3,154 |
| E. A. Wickham[6] | 1.15 | 2.20 | 49 | 8.50 | 2.00 | 3,254 |

[1] Marshalltown, Ia. [2] Boone, Ia. [3] Dubuque, Ia. [4] Des Moines, Ia. [5] Kansas City, Mo. [6] Council Bluffs, Ia.

PAVING, ETC.—Indianapolis Ind.—Contracts were let Sept. 14 for asphalting Delaware St., to the Western Paving & Supply Co., at $4.99 a lin. ft. of each side of the street, other bids being $5.08 and $5.10. The work is 1,478 × 30 ft., with 5,135 sq. yds. of asphalt, on 6 ins. Portland cement concrete; 2,933 ft. of stratified limestone curb, 113 ft. of granite round corners, 120 ft. of marginal stone, 4 inlets. Also for asphalting Market St., to the Indiana Bermudez Asphalt Co., at $7.99 a lin. ft. of each side of the street, to be done next year, other bids being $8.07, $8.10 and $7.45. The last bid was by the Capitol Paving & Construction Co., on California asphalt, and was rejected on the ground that the asphalt was unknown to the board of public works as a paving material. The work is 840 × 50 ft., with 4,885 sq. yds. of asphalt on 6 ins. Portland cement concrete, 1,752 ft. of stratified limestone curb, 88 ft. of granite round corners, 146 ft. of marginal stone, and 6 inlets. Also for cement walks on Forest Ave., to F. M. Snyder & Co., at 69 cts. a lin. ft., there being 1,198 ft. of walk 5 ft. wide, and 6,181 sq. ft. of cement. Also on 19th St., to the same, at 82 cts. a lin. ft., the walk being 315 ft. long, with cement 295 × 6 ft., or 1,812 sq. ft., and 20 ft. of walk stone and bouldering at alley crossings. Also for brick sidewalks on Chadwick St., to Geo. W. McCray, at 36 cts. a lin. ft., one other bid being 37 cts., the walk being 834 ft. long, and there being 804 ft. of brick walk 6 ft. wide, or 4,824 sq. ft., and 30 ft. of walk stone and bouldering. Also for brick pavement on Kentucky Ave., in two contracts, to the Capitol Paving & Construction Co., with Wabash Clay Co.'s brick. One contract at $5.25 a lin. ft. of each side of the street, 1,648 ft. × 37 ft., has 7,403 sq. yds. of surface on 6 ins. Portland cement concrete, 1,364 ft. of curb, stratified limestones, 211 ft. of granite round corners, 1,974 ft. of marginal stone, and 2 inlets. The other section, at $3.125, is 235 ft. long and 25 ft. wide, has 725 sq. yds. of surface, 200 ft. of curb, 19 ft. of granite round corners, 405 ft. of marginal stone, and 3 inlets. There were no other bidders.—Contracts were let Sept. 21 for cement sidewalk on Alabama St. to F. M. Snyder & Co., at $1.95 a lin. ft., the walk being 497 ft. long, and having 439 × 15 ft. of cement, or 6,588 sq. ft., and 57 lin. ft. of resurfacing. Also for cement walks on 10th St., to W. H. Peters, at 58 cts. a lin. ft., other bids being 65 to 74 cts., the walk being 2,588 × 5 ft., or 13,333 sq. ft. Also for cement sidewalk on Park Ave., to the same, at 69 cts., other bids being 79 to 87 cts., there being 3,536 ft. of walk, 3,380 × 6 ft., or 20,820 sq. ft. of cement, and 156 ft. of walk stone and bouldering at alleys.

PIER WORK, ETC.—Philadelphia, Pa.—We are informed that the following bids were received by Maj. C. W. Raymond, U. S. Engr., Sept. 23 for pier work and dredging in the Delaware River:

| Quantities. | | I. Lunt, New Castle, Del. | I. H. Hathaway & Co., Phila., Pa. | B. F. Sweeten & Son, Camden, N. J. | Delaware Construction Co., Wilmington, Del. |
|---|---|---|---|---|---|
| Yellow pine: | | | | | |
| Piles | 8,700 lin. ft. | $0.28 | $0.35 | $0.3192 | $0.29 |
| For sheet piling | 11 M. ft. | 40.00 | 45.00 | 38.82 | 36.00 |
| For braces, etc. | 11¼ " " | 35.00 | 45.00 | 51.68 | 36.00 |
| Bolts, nuts, etc. | 7,800 lbs. | .05 | .05 | .034 | .04 |
| Dredging | 3,500 cu. yds. | .40 | .45 | .35 | .45 |
| Total | | $5,068 | $6,022 | $5,260 | $5,220 |

BRICK PAVING.—Turtle Creek, Pa.—The awarding of contracts for paving 12 streets with brick was noted last week under Streets and Roads. S. A. Taylor, Engr., 908 South Ave., Wilkinsburg (Pittsburg), has sent us a detailed statement of the bids. The work in Penn Ave. was awarded to McConegly & Bennett, at $4,550, the bids being as follows:

Bids Received at Turtle Creek, Pa., for Brick Paving.

| Bidder. | Excavation, 1,120 cu. yds. | Curbing, 1,950 ft. | Curbing, rough, 100 ft. | Paving, 3,155 sq. yds., on— Gravel. | Annealed slag. | Mang'se slag. |
|---|---|---|---|---|---|---|
| Keeling, Ridge & Co., Josephine St., S. S. Pittsburg | $0.50 | $0.50 | $0.45 | $1.16 | $1.25 | $1.13 |
| John Schilp, 570 East St., Allegheny | .28 | .48 | .35 | 1.12 | 1.10 | 1.10 |
| J. C. Speath, 418 Dennison Ave., E. E. Pittsburg | .27 | .47 | .39 | 1.22 | 1.16 | 1.07 |
| Joseph Hastings, Allegheny | .32 | .50 | .42 | 1.17 | .... | 1.12 |
| McCready & Rosser, Braddock | .28 | .47 | .40 | 1.15 | .... | 1.08½ |
| Ross, P. Hauston, Pittsburg | .30 | .50 | .40 | 1.39 | 1.25 | 1.23 |
| W. A. Adams, 53 East Diamond St., Allegheny | .25 | .45 | .40 | 1.16 | 1.19 | 1.09 |
| McConegly & Bennett, Greensburg | .24 | .46 | .40 | 1.14 | 1.25 | 1.06 |

MACADAMIZING.—Griswold, Conn.—The following bids were received by C. E. Chandler, Engr., Norwich, Sept. 17, for macadamizing in this town, the bids for macadamizing being per lin. ft. for 6 ins. of macadam with a 16-ft. roadway:

| Quantities. | | R. A. Woodbury & Co., Central Falls, R. I. | Stone Road Construction Co., Bridgeport, Conn. | H. L. M. Ladd, Norwich, Conn. |
|---|---|---|---|---|
| Macadam | 3,960 lin. ft. | $1.00 | $1.00 | $1.15 |
| Culvert | 220 " " | 1.50 | 1.35 | 1.60 |
| Gutters | 652 sq. yds. | .35 | .50 | .60 |
| Total | | $4,518 | $4,583 | $5,297 |

ASPHALT AND GRANITE PAVING.—Schenectady, N. Y.—The Metropolitan Paving & Construction Co. submitted the lowest bids for paving portions of two streets, as follows: Asphalt pavement, $2.68 a sq. yd.; granite pavement, $2.98; curbing, 82 cts. per lin. ft.; catchbasins, $50 each; water taps, $8 each; sewer connections, 35 cts. per lin. ft.; ¾-in. A.A.A. lead pipe, 45 cts per ft.

SEWERS.—St. Louis, Mo.—B. H. Colby, Sewer Comr., has sent us the following tabulated statement of the lowest bids received Sept. 10 for 10 public and district sewers, all the bidders being residents of St. Louis:

Lowest Bids Received at St. Louis, Mo., for Constructing Sewers.

| Items. | Hill-O'Meara —Const'n Co.— Price. | Amount. | **Claus —Vieths.— Price. | Amount. | Lyons —Const'n Co.— Price. | Amount. | L. Wissmann. Price. | Amount. | J. H. Heman. Price. | Amount. | Lyons —Const'n Co.— Price. | Amount. | Shrainka —Const'n Co.— Price. | Amount. | August & J. C. Heman. Price. | Amount. | Shrainka —Const'n Co.— Price. | Amount. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Earth excavation | $0.24 | $720 | $0.22 | $1,826 | $0.27 | $608 | $0.19 | $1,216 | $0.20 | $14 | $0.17 | $1,411 | $0.20 | $1,060 | $0.19 | $608 | $0.20 | $80 |
| Brick masonry | 5.20 | 3,380 | 5.00 | 5,400 | 5.25 | 473 | 4.83 | 2,898 | 5.25 | 126 | 5.00 | 7,950 | 5.20 | 3,588 | 5.15 | 2,936 | 5.20 | 742 |
| 12-in pipe sewers | .44 | 18 | .... | .... | .27 | 891 | .55 | 33 | .40 | 352 | .... | .... | .45 | 1,170 | .30 | 822 | .35 | 138 |
| 15-in. " " | .... | .... | .... | .... | .42 | 197 | .55 | 11 | .... | .... | .... | .... | .54 | 1,890 | .37 | 1,036 | .46 | 721 |
| 18-in. " " | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .70 | 1,918 | .50 | 665 | .45 | 455 |
| 21-in. " " | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .92 | 1,260 | .90 | 486 | .60 | 192 |
| 24-in. " " | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1.32 | 280 | 1.00 | 720 | 1.10 | 440 |
| Junctions | .60 | 36 | .50 | 33 | .54 | 97 | .55 | 11 | .40 | 24 | .54 | 22 | .45 | 297 | .45 | 207 | .50 | 133 |
| Inlet stones | .42 | 23 | .60 | 32 | .50 | 189 | .55 | 59 | .40 | 32 | .... | .... | .45 | 352 | .40 | 443 | .40 | 184 |
| Cast iron | .019 | 44 | .02 | 106 | .015 | 143 | .025 | .... | .02 | 49 | .015 | 23 | .015 | 377 | .015 | 402 | .015 | 233 |
| Wrought iron | .036 | 16 | .03 | 20 | .015 | 18 | .035 | .... | .03 | 9 | .015 | 5 | .03 | 94 | .02 | 66 | .02 | 39 |
| 6-in. pipe sewers | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .40 | 10 | .20 | 6 | .30 | 3 |
| Rock excavation | .... | .... | 2.00 | 120 | 3.00 | 620 | .... | .... | .... | .... | .... | .... | 1.70 | 425 | .... | .... | .... | .... |
| Vitrified brick masonry | 8.00 | 440 | 10.00 | 460 | .... | .... | 8.50 | .... | .... | .... | 8.05 | 3,338 | 8.00 | 560 | .... | .... | .... | .... |
| Concrete masonry | *9.50 | 5,700 | 5.00 | 60 | .... | .... | .... | .... | .... | .... | 3.27 | 5,445 | .... | .... | .... | .... | .... | .... |
| | | $10,376 | | $13,298 | | $2,705 | | $4,702 | | $606 | | $18,103 | | $13,292 | | $8,397 | | $4,165 |

| | Shrainka —Const'n Co.— Price. | Amount. |
|---|---|---|
| Earth excavation | $0.20 | $80 |
| Brick masonry | 5.30 | 742 |
| 12-in pipe sewers | .46 | 138 |
| 15-in. " " | .53 | 721 |
| 18-in. " " | .56 | 762 |
| 21-in. " " | .72 | 490 |
| 24-in. " " | .... | 3,316 |
| Junctions | .55 | 187 |
| Inlet stones | .50 | 189 |
| Cast iron | .015 | 203 |
| Wrought iron | .04 | 68 |
| 6-in. pipe sewers | .25 | 5 |
| Rock excavation | .... | .... |
| Vitrified brick masonry | .... | .... |
| Concrete masonry | .... | .... |
| | | $6,899 |

* 8-ft. brick sewer, complete, in tunnel.
** Cutstone masonry, $25; total, $200; also 42 × 54-in. brick sewer in tunnel, through rock, complete, $6; total, $5,040.

SEWAGE DISPOSAL BEDS.—Plainfield, N. J.—The contract for constructing sewage disposal beds, as advertised in Engineering News, has been awarded to Washburn & Washburn, of New York and Chicago, the bids being as follows; A. J. Gavett, Constr. Engr.; James T. MacMurray, Cy. Clk.:

| Quantities. | P. T. Plunkett, Jersey City, N. J. | Washburn & Washburn, New York and Chicago. | B. H. Harrison & Sons, Newark, N. J. | M. Hogan & Sons, Chester, Pa. |
|---|---|---|---|---|
| Excavation: | | | | |
| Clearing and grubbing | $200.00 | $100.00 | $200.00 | $250.00 |
| Topsoil[1] ....7,000 cu. yds. | .23 | .12½ | .30 | .22 |
| Topsoil[2] ...14,000 " " | .23 | .17 | .30 | .20 |
| Below tops'139,000 " " | .23 | .17 | .30 | .19 |
| Screening tank 1 | 1,200.00 | 888.00 | 1,130.00 | 950.00 |
| Gate chambrs[3] 2 | 70.00 | 60.00 | 55.00 | 127.00 |
| Gate chambrs[4] 12 | 68.00 | 50.00 | 45.00 | 97.00 |
| 18-in. gates .. 13 | 15.00 | 15.00 | 18.00 | 7.00 |
| 12-in. gates .. 38 | 12.00 | 6.00 | 13.00 | 7.00 |
| Paved outlets 34 | 1.70 | 2.00 | 2.00 | 5.00 |
| Channels[5] ....7,020 ft. | .25 | .35 | .24 | .20 |
| 18-in. sewer ..3,075 " | 1.10 | .66 | .90 | .81 |
| 12-in. outlets . 500 " | .75 | .55 | .60 | .59 |
| Underdrains: | | | | |
| 3-in.[6] ..... 315 " | .26 | .30 | .20 | .15 |
| 3-in. tile ...6,910 " | .26 | .15 | .20 | .18 |
| 4-in. tile ..11,600 " | .20 | .10 | .22 | .18 |
| Vit. 4-in., 3,125 " | 2.30 | 1.60 | 1.60 | 1.51 |
| Manholes on 15 | 10.00 | 20.00 | 10.00 | 11.00 |
| On 24-in.. 4 | 27.00 | 37.00 | 30.00 | 37.50 |
| 4-in. c.i. pipe[7] 15 | 6.00 | 4.00 | 4.00 | 4.00 |
| Total | $34,127 | $24,662 | $34,867 | $27,567 |

[1] Below con. 50 and 51. [2] Above con. 50 and 51. [3] 4 x 6. [4] 4 x 4. [5] Brick-paved distributing channels. [6] Terra cotta. [7] In 12-ft. lengths.

BRIDGE PIERS.—Lowell, Mass.—Geo. Bowers, Cy. Engr., writes us that the following bids were received Sept. 26 for masonry pier and abutments, Moody St. bridge, all the bidders being residents of Lowell; contract awarded to Wm. H. Ward:

| Quantities. | Conners Bros., $52,753. | Wm. H. Ward, $21,455. | Pat. O'Hearn, $34,513. | L. F. Kittredge & Son, $37,007. |
|---|---|---|---|---|
| Earth excavation .. 240 cu. yds. | $0.60 | $0.50 | $0.75 | $0.50 |
| Rock excavation ....1,000 " " | 4.00 | 1.50 | 5.25 | 3.00 |
| Port. cem. concrete.. 15 " " | 8.00 | 8.00 | 13.00 | 10.00 |
| Abutment masonry ..1,030 " " | 24.00 | 7.00 | 12.75 | 14.00 |
| Abut. canal wall ....480 " " | 27.00 | 12.00 | 17.75 | 22.00 |
| Pier masonry ..... 360 " " | 28.00 | 17.00 | 18.50 | 22.00 |
| Ledge stone ..... 50 " " | 7.00 | 6.00 | 5.50 | 6.00 |
| Wrought iron ..... 150 lbs.... | .06 | .20 | .25 | .15 |
| Manhole and 24-in. brick sewer.. | 250.00 | 175.00 | 383.00 | 350.00 |
| Rubble masonry .... 30 cu. yds. | 4.00 | 4.00 | 6.00 | 5.50 |

WATER-WORKS.—Westwood, O.—Robert A. Armstrong, Village Clk., writes us that contracts for furnishing and laying 28,000 ft. of water pipe, etc., as advertised in Engineering News, have been awarded as follows: Addyston Pipe & Steel Co., 67 tons of 10-in. pipe, 207 tons of 8-in., 89 tons of 6-in., and 139 tons of 4-in. pipe, at $25 a ton, and special castings at $50 a ton; Geo. B. Hawley, of Cincinnati, 22,000 lbs. of pig lead, at 3½ cts. per lb.; Bourbon Copper & Brass Works, 10-in. valves, 2, at $21 each; 8-in., 6, $14.30; 6-in., 7, $9.25; 4-in., 41, $6; boxes, $2.60; double-nozzle fire hydrants, 24, $18.70; T. J. Mulligan, Ironton, O., laying 10-in., 8-in., 6-in. and 4-in. pipe, 15½ cts., 14½ cts., 12¾ cts. and 11⅞ cts. per ft., respectively, and $1.75 for each hydrant.

SEWERS.—Scranton, Pa.—Joseph P. Phillips, Cy. Engr., writes us that the following bids were received by select council Sept. 26: For lateral sewer on Capouse Ave., between Green Ridge and Marion Sts., 12-in. pipe, 4 manholes, average depth 11 ft.—M. A. Donohue, Scranton, $1.75 per lin. ft.; Hart & Gibbons, Wilkes Barre, $1.74. For lateral sewer on Irving Ave., 24-in. pipe, 2 manholes, 1 catch basin, average depth 9 ft.—M. A. Donohue, Scranton, $2.18 per lin. ft.; Hart & Gibbons, Wilkes Barre, $2.09.

BRICK PAVING.—Evansville, Ind.—Aug. Pfaffiin, Cy. Engr., writes us that the city awarded contracts Aug. 21 for 53,000 sq. yds. of brick paving, to cost $106,000, as follows: Eichel, Arnold & Co., at $1.60 a sq. yd., and to Weikel & Nugent, at $1.55.

SEWER.—Oakland, Cal.—The following bids were received for constructing a sewer from the infirmary to the bay: A. C. Metavische, 18,500 ft. of 8-in. pipe, laid at 46 cts. per ft., 5 manholes at $37 each, 12 vertical vent pipes at $2.50 each, 24 T's or Y's at 75 cts. each; total, $8,743; Edward Kavanaugh and L. Kehoe, total, $8,585; T. G. Harrison, $5,683; P. Heverin, $5,880; Thomas R. Bassett, $6,944; John Greany, $7,426; John Geary, $5,938; Anson S. Blake, $6,432; J. T. Cochran, $6,480.

DITCH.—Monticello, Ind.—Web. P. Bushnell, Engr., writes us that all the contracts for the Headlee ditch, with branches, were awarded to local bidders at very low prices, the most of the work being sold at 7 cts. a cu. yd., and some as low as 4.98 cts. The entire length is about 17 miles, and the work is largely scraper work.

ARTESIAN WELLS.—Nyack, N. Y.—The contract for drilling artesian wells, as advertised in Engineering News, has been awarded the Germantown Artesian Well Co., of Germantown, Columbia county, N. Y., at $3 a ft. for 8-in. well to limit of 450 ft. depth; well to be driven at tide water of Hudson River in red sandstone. Jas. S. Haring, Engr.

TUNNEL, ETC.—New York, N. Y.—The contract for constructing tunnel, tower, pier and appurtenances at the new high-service pumping works, for conveying coal from the Hudson River, was awarded Sept. 27 to Jas. R. Kelly & Co., 26 Cortlandt St., New York, at $24,375. The total bids were published in our issue of Sept. 12. The itemized bids were as follows:

| Quantities. | | J. R. F. Kelly & Co., $24,375. | W. J. Rogers, $24,470. | P. J. Moran, $25,350. | Thos. Dwyer, $25,770. | Patrick Burns, $27,000. |
|---|---|---|---|---|---|---|
| Rock | 6,000 cu. yds. | $0.50 | $2.35 | $1.80 | $1.50 | $1.85 |
| Earth | 1,000 " " | .75 | .20 | .25 | 1.00 | .60 |
| Embankment | 500 " " | 2.00 | .10 | 1.00 | 1.50 | .60 |
| Cut stone | 15 " " | 80.00 | 60.00 | 50.00 | 60.00 | 60.00 |
| Broken ashlar | 400 " " | 12.00 | 8.00 | 14.00 | 17.00 | 13.00 |
| Stone masonry | 700 " " | 8.00 | 5.00 | 4.50 | 4.00 | 4.75 |
| Brick masonry | 50 " " | 15.00 | 8.00 | 11.00 | 10.00 | 10.50 |
| Concrete | 150 " " | 15.00 | 5.00 | 5.50 | 6.00 | 5.00 |
| Dry stone masonry | 100 " " | 3.00 | 1.00 | 2.00 | 3.00 | 4.00 |
| Wrought iron | 24,000 lbs. | .10 | .02 | .035 | .04 | 5.00 |
| 12-in. c. i. pipe | 150 lin. ft. | 1.50 | 1.00 | 1.50 | 2.00 | 2.00 |
| Cast iron | 2,000 lbs. | .05 | .02 | .03 | .03 | .05 |
| Crib | 2,000 | 600 | 1,000 | 1,500 | 2,300 | |

BRICK AND MACADAM PAVING.—Dunkirk, N. Y.—John K. MacDonald, Cy. Engr., writes us that no contracts have yet been let for the 53,000 sq. yds. of pav-

Bids Received at Youngstown, O., Sept. 16, for Two 5,000,000-Gallon Pumping Engines.

| Bidder. | Class of engine. | Class of pump. | Size cylinders, ins. H.p. | Int. | L.p. | No. cylinders. | Size plunger, ins. | Piston speed Length stroke, ins. | feet per min. | No. of revs. per min. | Duty. | Steam pressure, lbs. | Price two engines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E. P. Allis Co. | Vert. triple[1] | S. A.—O. P. | 20 | 36 | 52 | 3 | 18½ | 36 | 168 | 28 | 130 | 120 | $57,000 |
| " " " " | " " [1] | " " " " | 22 | 38 | 56 | 3 | 20 | 36 | 144 | 24 | 128 | 120 | 58,000 |
| " " " " | " " [1] | " " " " | 24 | 40 | 56 | 3 | 18½ | 36 | 168 | 28 | 120 | 80 | 58,000 |
| " " " " | comp.[2] | Diff. | 26 | .. | 48 | 2 | 16 x 22½ | 36 | 168 | 28 | 110 | 120 | 39,000 |
| " " " " | " " [2] | " | 28 | .. | 52 | 2 | 17½ x 24½ | 36 | 144 | 24 | 108 | 120 | 40,500 |
| " " " " | " " [2] | " | 30 | .. | 54 | 2 | 16 x 22½ | 36 | 168 | 28 | 100 | 80 | 40,500 |
| Geo. F. Blake Co. | Hor. cr. comp. | D. A. | 21 | .. | 42 | 2 | 13½ | 36 | 254 | .. | 120 | 120 | 51,300 |
| " " " " | D. C. | " | 8¾ | .. | 36 | 4 | 19 | 36 | .... | .. | 65 | 80 | 32,895 |
| Fraser & Chalmers | Vert. cr. comp.[3] | S. A. | 17½ | .. | 35 | 2 | 15¾ | 36 | 480 | 80 | 130 | 120 | *27,500 |
| Fraser & Chalmers | Vert. cr. comp.[3] | S. A. | 17 | .. | 28 | 2 | 9½ | 36 | 480 | 80 | 130 | 120 | 45,000 |
| Groshon Pump. Eng. Co. | Vert. triple | Diff. | 26 | 40 | 58 | 3 | 12¾ x 18½ | 36 | 180 | 30 | 130 | 120 | 55,000 |
| Groshon Pump. Eng. Co. | Vert. cr. comp. | " | 28 | .. | 56 | 2 | 15¾ x 22½ | 36 | 180 | 30 | 115 | 120 | 46,000 |
| Holly Mfg. Co. | Hor. comp. | D. A. | 24 | .. | 42 | 4 | 19 | 36 | 125 | .. | 115 | 120 | 47,800 |
| Holly Mfg. Co. | Vert. triple | S. A. | 20 | 34½ | 51 | 3 | 17½ | 36 | 194 | .. | 130 | 120 | 55,500 |
| Holly Mfg. Co. | Vert. cr. comp. | D. A. | 24 | .. | 42 | 2 | 15¼ | 36 | 195 | .. | 115 | 120 | 42,900 |
| Nordberg Co. | Vert. triple | D. A. | 15½ | 27½ | 41 | 3 | 11 | 48 | 240 | 30 | 135 | 120 | 54,500 |
| Penn. Iron Works | Hor. cr. comp.[4] | D. D. | 21 | .. | 42 | 2 | 14½ | 36 | 216 | .. | 100 | 120 | 48,000 |
| Snow Pump Works | Hor. cr. comp. | D. A. | 24 | .. | 48 | 2 | 16½ | 36 | 160 | 26.7 | 115 | 120 | 38,976 |
| Snow Pump Works | Duplex | D. A. | 20 | .. | 40 | 4 | 15 | 36 | 125 | 27 | 60 | 80 | 30,665 |
| Snow Pump Works | Hor. triple | D. A. | 17 | 29½ | 34 | 4 | 15½ | 36 | 186 | 31 | 125 | 120 | 46,188 |
| William Tod & Co. | Hor. cr. comp.[4] | D. A. | 25 | .. | 50 | 2 | 18 | 36 | 140 | .. | 110 | 120 | 38,000 |
| William Tod & Co. | Hor. cr. comp.[5] | D. A. | 26 | .. | 52 | 2 | 18 | 36 | 140 | .. | 110 | 120 | 39,500 |
| William Tod & Co. | Vert. cr. comp.[5] | D. A. | 26 | .. | 52 | 2 | 18 | 36 | 140 | .. | 110 | 120 | 46,000 |
| H. R. Worthington | Dup. comp. H. | D. A. | 21 | .. | 42 | 4 | 19 | 36 | .... | .. | 105 | 120 | 47,550 |
| Wilson & Snyder | Hor. cr. comp. | D. A. | 22 | .. | 42 | 2 | 15 | 36 | 200 | .. | 110 | 120 | 35,770 |
| Wilson & Snyder | Duplex | D. A. | 21 | .. | 42 | 4 | 21¼ | 36 | 100 | .. | 60 | 80 | 29,000 |

[1] Two pair of foundations, $1,500 extra. [2] Two pair of foundations $1,000 extra, and $1,500 extra for outside packed plunger. [3] Reidler valve gear. [4] Piston valves. [5] Corliss valves. * Each. ** The duty is in million gallons; ft.-lbs. per 100 lbs. of coal.

## INDUSTRIAL NOTES.

THE WELLAR PIPE WORKS, of Gadsden, Ala., is reported as having built a large addition to its plant.

THE UNION CHAIN WORKS, of Allegheny, Pa., has increased the capacity of its plant.

THE DIXON CAR WHEEL CO., of Houston, Tex., will build a foundry for architectural ironwork and general casting.

THE AKRON STEEL FORGE WORKS, of Elwood, Ind., has recently completed some very heavy shafts for Eastern engine builders.

THE LODGE & DAVIS MACHINE TOOL CO., of Cincinnati, O., has a contract for some large gun lathes for the Brooklyn navy yard.

THE INTER-STATE IRON WORKS, of Meridian, Miss., had its plant destroyed by fire Sept. 28; loss reported at $30,000, with $6,000 insurance.

THE NEW CASTLE KEYSTONE PLOW CO., of New Castle, Pa., is reported to have purchased a tract of land, and will soon erect a brick factory.

THE FINISHED STEEL CO., of Hamilton, has about completed its new buildings, for the manufacture of polishing shafting, and will at once install the machinery.

THE MURPHY IRON WORKS, Jacksonville, Fla., is building an ocean-going tugboat 127 ft. long, 24 ft. beam and 10 ft. deep, fitted with a 600-HP. triple expansion engine.

THE AMERICAN BRIDGE WORKS, of Roanoke, Va., is said to have been purchased by Samuel Walton, of Tazewell, Va. Repairs will be made and operations resumed at once.

THE ERIE CAR WORKS, at Erie, Pa., is reported as having received an order for 50 gondola coal cars of 50,000 lbs. capacity from Messrs. H. K. Wick & Co., of Buffalo, N. Y.

THE M. C. BULLOCK MFG. CO., of Chicago, Ill., has a contract for two Wiliams central-valve engines of 200 and 400 HP. for the Pabst Heat, Light & Power Co., of Milwaukee, Wis.

THE BALDWIN LOCOMOTIVE WORKS, of Philadelphia, Pa., is reported as having received contracts for 40 locomotives, 20 each for passenger and freight service, for Russian railways.

THE OHIO TUBE CO., of Warren, O., manufacturing wrought iron and steel pipes, has completed the erection of a new galvanizing plant, and is building a new furnace in the butt weld department.

THE HERRESHOFFS MFG. CO., of Bristol, Conn., has been awarded the contract by the government for building two torpedo boats, at $144,000 each. The bids were published in our issue of Sept. 19.

THE PITTSBURG WIRE CO., of Braddock, Pa., is reported to be building an addition to its plant, to be used as a wire nail department. It is expected that 35 nail machines will be in operation within two months.

THE FULTON IRON WORKS, of San Francisco, Cal., is building an iron twin-screw steamer for service on the Sacramento River. It is 77½ ft. long, 11½ ft. beam and 3½ ft. draft, and will have a speed of 16 knots.

THE GLOBE IRON WORKS, of Cleveland, O., has the contract for 18 steel canal barges for the Cleveland Steel Canal Boat Co. Three of these will have engines of 250 HP. to drive a propeller, and will tow five barges.

THE DAVIS & THOMAS CO., of Catasauqua, Pa., has a contract for the yoke castings of a 14-mile extension of the Metropolitan Electric Ry., of Washington, D. C., a conduit line. The contract calls for the casting of about 6,000 tons.

T. K. McKNIGHT & CO., of Pittsburg, Pa., manufacturers of "Kaolin" covering for steam pipes, is reported to have received an order from the Pittsburg Iron & Steel Mfg. Co., Soho, which calls for about 33,000 sq. ft. of covering.

THE TOTTEN & HOGG IRON & STEEL FOUNDRY CO., of Pittsburg, Pa., manufacturing rolling mill engines and machinery, has received an order for 62 large rolls and three trains of rolls, a 21-in., a 16-in. and a 12-in. train, with rolls complete.

THE CHICAGO PRESSED STEEL CO., of Chicago, Ill., has been incorporated by J. L. Wilson, J. M. Horn and Edward L. Lamb, and intends to erect a plant at Chicago Heights for the manufacture of steel ties, tie-plates, etc. Capital stock, $500,000.

THE MORAN BROS. CO., of Seattle, Wash., has been awarded the contract to construct one of the new torpedo boats, on condition that Chief Engineer Wilson, of the Mare Island navy yard, makes a favorable report of the company's capacity to do the work.

THE NORDBERG MFG. CO., of Milwaukee, Wis., is said to be considering offers from the cities of Holland and Grand Rapids, Mich., for the removal of its works. The present plant at Milwaukee, which is rented, has become too small for the company.

THE WEST SUPERIOR IRON & STEEL CO., of Superior, Wis., is reported as renewing its efforts to get its affairs in such shape that the works may be reopened. The plant is said to be one of the most complete in the country, and is now in the receiver's hands.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., states that the new machine shop which it has designed and built for the Granger Foundry & Machine Co., at Providence, R. I., will be one of the largest and most complete in the New England states. The building is 110 × 306 ft.

THE WOODSTOCK IRON CO., of Anniston, Ala., is increasing the capacity of its No. 4 furnace from 100 tons to 165 tons of pig iron a day. Three of the five old engines are being overhauled and repaired, one new blowing engine of 600 HP. will be put in and an additional hot-air stove will also be erected.

THE CLEVELAND STEEL CANAL BOAT CO., of Cleveland, O., counts the first trip of its first fleet to New York with steel rails from Lorain, O., a success. It has decided to build four more fleets, consisting of a steamer and five barges each, making 30 boats in all. The barges will cost about $3,000 each and the steamers $7,000.

THE NEW CASTLE TUBE CO., of New Castle, Pa., manufacturing seamless steel tubes, has decided to double the original intended capacity. It was proposed to start the plant with 20 benches for the drawing of tubes, but this has been reconsidered and 40 benches will be put in. The firm expects to be in full operation in December.

THOMPSON & GRAY, of St. Louis, Mo., have secured the contract for stone abutments and piers on the St. Louis division of the Missouri, Kansas & Texas Ry. The specifications cover over ten bridges, and the cost will be about $200,000. The same firm has also the contract for stone ballast on the entire division, a distance of 186 miles.

THE GOULDS MFG. CO., of Seneca Falls, N. Y., is having a large sale of its triplex power pumps. Among recent orders may be mentioned several for the Tide Water Oil Co., Bayonne, N. J.; Newton Falls Pulp Co., Newton Falls, N. Y.; Westinghouse, Church, Kerr & Co., Boston, Mass.; and the Syndicate Improvement Co., of Rawlins, Wyo.

THE PITTSBURG STEEL & IRON CO., of Pittsburg, has started up its large steel plate mill. Both open-hearth steel furnaces are in operation, and the old Soho blast furnace is turning out 250 tons of pig iron a day. The entire output of the latter is sold up to January. The galvanizing works have not yet been started, but it is expected that they will be before long.

THE SHELBY STEEL TUBE CO., of Shelby, O., has started up two new engines, one to run 35 benches in the draw-room and the other to run an electric light plant for 70 arc and 600 incandescent lights. A new three-story building is also being built, and when this is finished and equipped the works will have 60 benches and a monthly capacity of 1,500,000 to 2,000,000 ft.

THE POTTER & HOLLIS FOUNDRY CO., of Chicago, Ill., has been incorporated with a capital stock of $10,000, and a press report states that it has leased from the C. A. Treat Car Wheel Foundry Co. the grounds and buildings belonging to that concern at East Chicago. The purchasers have already taken possession, and will shortly begin the manufacture of a high grade of machinery and tool steel.

THE LINK-BELT MACHINERY CO., of Chicago, Stanton B. Peck, Consult. Engr., informs us that among other contracts recently secured are the following: Equipping the Amazon Hosiery Co., Muskegon, Mich., with a 150-HP. rope transmission plant; complete coal and sugar conveying plant for the Fourche Planting Co., Little Rock, Ark.; a 500-HP. boiler plant for the Cincinnati (O.) Edison Electric Co.

THE CENTRAL STAMPING CO., 25 Cliff St., New York, has purchased the machinery and tools of the Steel Edge Stamping & Retinning Co., Millis, Mass., which recently closed its works, and has also leased the Millis factory for one year, with the object of starting at that place the manufacture of some of the lines of tinware and sheet metal goods which were formerly made at the company's works at Newark, N. J., recently destroyed by fire.

THE AMERICAN TINPLATE CO., of Elwood, Ind., has increased its capital stock to $1,200,000. The company's large works, comprising 16 hot mills, 14 cold rolls, and 22 tinning stacks, are now in full operation, placing the concern among the largest producers of tinplates in the world. It is now enlarging its plant for the fifth time since its first construction, and will also build, in addition, a steel plant for the manufacture of all kinds of steel goods for the trade and factory use, which will require at least 500 more hands.

THE S. R. SMYTHE CO., Lewis Block, Pittsburg, Pa., is building the basic and open-hearth furnaces, cranes and other equipment, and also the heating furnace for the 132-in. plate mill for Worth Bros., at Coatesville, Pa., and has a contract from the Lukens Iron & Steel Co., also of Coatesville, for the erection of two 35-ton, open-hearth furnaces, with gas producers and other accessories. There are said to be over 800 of the Smythe patent water scale continuous gas producers in service.

THE KINGSTON CAR WHEEL CO., of Kingston, Pa., has erected a new car wheel foundry, and is prepared to fill orders from steam or street railways. An interesting feature of the plant is a car wheel molding machine, which has a capacity of 400 wheels per day of 10 hours. It has turned them out at the rate of one per minute. By the ordinary methods of hand molding a molder and helper complete about 20 flasks per day. So far as we recall, this is the only car wheel molding machine which has ever been made a practical success.

CURRAN & HUSSEY, of Pittsburg, Pa., have received contracts for the erection of the following buildings for the Apollo Iron & Steel Co.: Boiler house, 47 × 200 ft. and 36 ft. high from top of foundations to under side of chord; open-hearth building, 53½ × 1,120 ft., part of which is 40 ft. high from top of foundations to under side of chord, and another part 34 ft. high, on one side of this building being a lean-to shed 45 × 402½ ft., and another shed 35 × 350 ft.; and an annealing house 80 × 200 ft. and 34 ft. high.

THE TOLEDO CONSTRUCTION CO., railroad contractors, of Toledo, O., is doing a large amount of electric railway work in connection with its general line of contract work. It is now building 18 miles of road from Toledo, O., to Petersburgh, Mich.; 22 miles from Ft. Wayne to Columbus City, Ind.; 16 miles from Akron to Canton, O. All the above are suburban electric railways. Several contracts have already been closed by the company for electric railways, to be built in the early spring. The company has recently placed 10 Ideal engines in the new steel building of Spitzer & Co., bankers, and one in the Toledo electric light plant.

NEW COMPANIES.—Hatch Storage Battery Co., Philadelphia, Pa.; $5,000,000; George D. Armstrong, John W. Betel and Theo. Hansen.

Riverside Gas, Light & Heat Co., Riverside, Ill.; $100,000; L. J. Highland, J. E. Sutherland, and J. Down.

National Mining, Tunnel & Land Co., Cripple Creek, Colo.; $1,500,000; Clinton S. Fletcher, W. B. Foley, and others.

Egyptian Cement & Plaster Co., Merrill, Wis.; $10,000; W. H. Monroe, T. B. McNutt, W. D. Martin, all of Merrill.

Waukesha Malleable Iron Co., Waukesha, Wis.; $60,000; C. A. Haertel, C. G. Deissner and Andrew Snyder.

Mayo-Damper Co., Pottstown, Pa.; $15,000, with $1,500 paid in; iron and steel work; Treas., Roy A. Hatfield.

Fairfield Building Co., Fairfield, Me.; to erect buildings; $5,000; Pres., S. A. Nye; Treas., E. F. Filer; both of Fairfield.

Bailey-Fletcher Metal Milling Co., Cripple Creek, Colo.; $100,000; John W. Bailey; Donald Fletcher, and Isaac T. Beck.

Falls City Mining Co., Spokane, Wash.; $500,000; George W. Dawson, George A. Hurd, G. L. Gilliland, and W. E. Leigh.

Rex Fire Extinguisher Co., New York city; $20,000; Benjamin F. Brown, 72 Duane St.; Wm P. Ward, and James W. Clarke.

Kansas City Wheel Scraper Co., Kansas City, Mo.; $15,000; Nicoll H. Comstock, Daniel C. Brown, and Edward A. Brown.

International Car Co., Portland, Mo.; $500,000; Pres., John L. Bixby, Jr.; Treas., George C. Tewksbury, both of Arlington, Mass.

Charles F. Elmer Engineering Works, Chicago, Ill.; $50,000; Charles F. Elmer, Carleton L. Elmer and Geo. E. Dickson, of Chicago.

Moon Elevator Co., St. Louis, Mo.; $20,000, all paid in; Edward W. Moon, Joseph M. Rooy, and Charles H. Pellet, all of St. Louis.

River St. Clair Construction Co., Ltd., Detroit, Mich.; railway construction; $1,000; Treas., James Miller; Secy., Lester B. French.

Mexican Asphalt Paving Co., Chicago, Ill.; $50,000; Geo. W. Crichfield, G. E. Roussmann, G. W. Morrison, and W. T. S. Critchfield.

American Electric Construction & Supply Co., Parkersburg, W. Va.; $100,000; W. Clay Leonard, Jr., H. L. Hickey, and C. V. Webber.

New York Deposit Safe Co., Buffalo, N. Y.; to make safes; $10,000; Hiram P. Hopkins, W. P. Hazard and W. G. Hopkins, of Buffalo.

Newburg Ice Machine & Engine Co., Newburg, N. Y.; $300,000; Edgar Penny, Newburg; Geo. B. Salisbury, New York city, and others.

Combination Fuel Oil Burner & Gas Producer Co., Chicago, Ill.; $25,000; Ira G. Wood, Howard M. C. Writer and Robt. C. Chapman.

Eureka Street Sweeper Co., Jersey City, N. J.; $200,000, all paid in; Philip L. Merchutt, Thos. A. Low, and E. O. Pease, all of Jersey City.

Mount Vernon & Terre Haute Construction Co., East St. Louis, Ill.; bridges, railways, etc.; Wm. S. Carter, Daniel C. Taylor and E. Smith.

Empire State Granite Co., Paterson, N. J.; $25,000, all paid in; John Hinchliffe, Wm. F. Hinchcliffe, Jas. C. Hinchliffe, all of Paterson, N. J.

Keller-MacKinnon Mfg. Co., Chicago, Ill.; to manufacture enamel wares, etc.; $50,000; Herman D. Keller, Alex. P. MacKinnon, and Arthur Gauradgo.

Texas Co-operative Mfg. Co., Waco, Tex.; to manufacture vehicles and agricultural machinery; J. W. Riggins, Loury Migel, W. J. Miller and others.

Rock Creek Natural Asphalt Co., Topeka, Kan.; $100,000; John Bradley, Charles Wilbur, I. N. Wheatley, Topeka, Kan.; W. A. Dennis, of Marinette, Wis.

The Spathite Iron Co., of Alabama, Sheffield, Ala.; Thomas Strap, H. W. Buttorff, and Wm. Livingston, of Nashville, Tenn., and Thomas R. Rouhl, of Sheffield.

Star Gas Control Co., Jersey City, N. J.; $100,000, with $1,000 paid in; Wm. C. Bromer, of Jersey City; J. W. Doolittle and Wm. T. Neiman, of New York.

Jackson Gate Gold Mining Co., San Francisco, Cal.; $1,000,000, with $25,000 paid in; Frederick C. Stele, J. W. Ellis, H. H. Paulsen and others, of San Francisco.

Backus Gas Heater Co. of Kansas City, Camden, N. J.; $50,000, with $1,000 paid in; Hubert W. Davies, of Camden, N. J., and John W. Cowan, of Philadelphia, Pa.

Asphaltum Block Paving Co., San Francisco, Cal.; $100,000, all paid in; Alfonso Hoskins, of Oakland; John H. Bullock and Loring B. Doe, of San Francisco.

Atlas Steel Converting Co., Camden, N. J.; $250,000, with $1,000 paid in; Chas. S. Hearon, Camden, N. J.; Thos. Reed, Philadelphia, Pa.; Saml. B. Taylor, Beverly, N. J.

Stewart Construction Co., Columbia, S. C.; to dig canals, dredge, etc.; $40,000; J. E. Burgiss, Savannah, Ga.; A. P. Steuart, T. J. Harper and W. H. Lyles, of Columbia, S. C.

Saxton Iron Co., Philadelphia, Pa.; $150,000, with $15,000 paid in; Jacob Toms, of Port Deposit, Md.; John W. Moffey, Lucien Brown, John F. Craig, and Wm. W. Kurtz, of Philadelphia.

Monarch Brake-Beam Co., Detroit, Mich.; to manufacture brake beams and railway appliances; $150,000; Joseph H. Berry, Thomas H. Simpson, Geo. Fuller & Wm. G. Smith, Detroit.

Calcium Carbide Lighting Co., Jersey City, N. J.; $200,000, with $1,000 paid in; Daniel Y. Lewis and George B. Fielder, of Jersey City; Winfield S. Chamberlin, of Bayonne, N. J.

Charles Roberts & Co., Greenburg, N. Y.; consolidating the Clymer Mfg. Co. and Chase-Roberts Co.; $50,000; W. D. Chase, Eldoran M. Roberts and S. W. North, of Brooklyn, N. Y.

Western Improvement Co., San Francisco, Cal.; $50,000, with $10,000 paid in; paving, concrete work, piling, etc.; Thomas Moran, San Francisco, and W. R. Porter, San Bernardino.

Kirkland, Litchfield & Co., New York, N. Y.; to mine and manufacture slate products; $10,000; Wm. H. Kirkland and Edward Kirkland, New York, and Noah A. Litchfield, Bangor, Me.

Guyandotte Construction Co., Jersey City, N. J.; $100,000, with $1,000 paid in; James H. McCreery, Pittsburg, Pa.; John F. Van Deventer, Elizabeth, N. J.; and Howard C. Bolton, New York city.

Latrobe Steel Co., Philadelphia, Pa.; to operate the Latrobe Steel Works, at Derry; $1,000,000, all paid in; Howard Wood, Horace Magee, of Philadelphia, and Elwood W. Kimber, Germantown, Philadelphia.

Clifford Mfg. Co., of Rochester, N. Y.; to manufacture and sell the Clifford automatic smoke consumer, mechanical stoker, etc.; $100,000; Thomas F. Clifford, G. W. Kirkpatrick, B. C. Montgomery, and G. D. Reed, of Rochester.

New York Lubricating Oil Co., New York city; to manufacture and sell oils and grease; $60,000; F. C. Jones and William Crosby, of New York; W. W. Dushell, of Arlington, N. J., and E. B. Curtis, of Stamford, Conn.

Chormann Mfg. Co., Pittsburg, Pa.; mechanical indicators and advertising devices for street cars, ferry boats, etc.; $5,000; Alvin W. Chormann, Washington, Pa.; James H. Rankin, Sewickley, Pa., and Wm. H. Baird, Pittsburg.

Schwencke & Kirk Co., of New York city; to make and sell mathematical and engineering instruments and supplies; $60,000; Julius Schwencke, Julius Boettner, and Thomas Dick, of New York city, and B. C. Kirk, of Glen Cove, N. Y.

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